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ABSTRACT

Recent studies have focused attention on the fact that residents of inner-city neighborhoods are subject to greater amounts of pollutants than are other neighborhoods of large cities. In this study, the premise is set forth and investigated at the metropolitan scale, seeking to discover differences of impact between the center city and its suburbs. The report hypthesizes differentials of a generalized metropolitan area, by pollutant types and by interpreting diverse information sources. The findings were considered in the light of standards imposed by federal and state regulation, first uniformly enforced, then implications for variable enforcement. (Author/BB)

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February 1974

STUDIES IN ENVIRONMENT

VOLUME III

POLLUTION AND THE MUNICIPALITY

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Recent studies have focused attention on the fact that residents of inner-city neighborhoods are subject to greater amounts of pollutants than are other neighborhoods of large cities. In this study, Pollution and the Municipality, the premise is set forth and investigated at the metropolitan scale, seeking to discover differences of impact between the center city and its suburbs.

The report hypothesizes differentials of a generalized metropolitan area, by pollutant types, by interpreting diverse information sources. The findings were looked at in the light of standards imposed by federal and state regulation, first uniformly enforced, then implications for variable enforcement.

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SECTION I

INTRODUCTION

The purpose of this research is threefold. First, current levels of environmental differentials existing between inner city and suburban locales will be reviewed with emphasis upon the sources and nature of center city environmental pollution as they are linked to the polluters. Secondly, the effects of environmental pollution on human health are discussed. Finally, the ramifications of uniformly enforced Federal environmental standards to center city locales and constituent populations are analyzed.

The methodology applied to the questions of uniform application of Federal controls to the center city involves a review of current research in the field of environmental pollution. This is done through a presentation of case studies and survey data.

In order to analyze the differences between suburban and center city environmental quality, the characteristics of each area must be established and the sources of the differences discovered. The potential development of uniformly enforced Federal controls can only be accomplished after key concepts are understood in an operationally significant manner.

I.A Center City and Suburban Differentials

For this report, a differentiation is made between the center city locale and the suburban locale. The metropolitan community is subdivided into the population residing "inside the central city or cities" and the population residing "outside the central city or cities."[1] It is the population inside the central city or cities which defines the center city locale. The outside area is commonly referred to as the suburban ring.[2] This suburban ring definition defines the suburban locale in this report. The center city is also distinguished from the suburb by its greater development and more dense population.

It is also necessary to distinguish between the natural and the built environments of the center city. The natural environment, as defined here, constitutes those physical characteristics existing in natural forms. The components of the natural environment are ambient air, water resources, solar energy, soil, vegetation and terrestrial and aquatic animal life. Noise, solid wastes, radiation and toxic chemical substances are considered as additions to the natural environment produced by natural and man-made processes. The built environment as defined here comprises the buildings, roads, transport systems, pipe lines, power lines and other man-made structures in the center city locale.

I.B Demographic Data

The demographic composition of the center city differs from that of the suburbs. The center city is characterized by a higher median age, lower median income, higher percent poor and a higher percent non-white. The median age inside the center city is 30.1 years compared to 26.9 years in the suburban locale. People over 65 compose 11.1 percent of the central city population as compared to 7.5 percent of the suburban population. Race-specific data indicate a similar age distribution for those aged 65 and over.

The median income for all families residing in the center city was $7,420 compared to a median income of $8,350 for suburban families.[3] Besides the lower median income earned by center city families, a larger proportion of these residents earn incomes classified as "below poverty level." Census data collected in 1970 show that 13.4 percent of the population within the center city are below the poverty level.[4]

Race-specific data indicate a substantial difference in the percent of the black population residing within the center city as compared to the suburban ring. The proportion of blacks inside the central city locales was greater for metropolitan areas of 1,000,000 or more than smaller metropolitan areas in 1970.

These statistics present the current demographic distribution of the metropolitan population within center city and suburban locales. Historically, a selective process of outmigration has produced an ethnically homogeneous center city. It is hypothesized that this selective shifting of the population to the suburbs will result in black majorities in most important cities in the U.S. in this decade.[5] Campbell and Shalala note that the phenomenon of "white middle-class exodus" to the suburbs started in the 1940's.[6]

To sum, the areas of investigation are the center city and the suburban locale, defined by the Census Bureau as that area inside the central city or outside the central city, respectively. Structurally, the center city is more densely populated and more developed. Distributional data show a lower median income, higher median age, greater proportion age 65 and over and a higher percent black population. It is this risk population to which the research addresses itself in the following sections of this report.

I.C Overview of Research

The problem of environmental differentials is essentially a question of specifying what the levels of pollution are and determining who is producing these differential levels. The following findings suggest that the center city locale is different from the suburban locale because of a greater magnitude of pollutants. As previously stated, each pollutant category is comprehensively covered in relation to differentials in sources of pollution, health effects and pollution controls. Each category has causal significance when approaching the sources and nature of differential pollution. The causes of varying levels of pollution are a function of the peculiar internal structure of the center city. The following data are presented to support the hypothesis that the internal structure of the center city is associated with its differentially polluted environment.

The first category to be covered is that of air pollution and its affect upon the center city.

FOOTNOTES

1. U.S., Department of Commerce, Bureau of Census, Number of Inhabitants, United States Summary (Washington, D.C.: Government Printing Office). The "central city" is defined as any city within a Standard Metropolitan Statistical Area with a population of 50,000 or more.

2. Ibid., pp. XII-XIII.

3. U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Special Studies, "Social and Economic Characteristics of the Population in Metropolitan and Metropolitan Areas," Series P-23 (Washington, D.C.: Government Printing Office, 1970).

4. Ibid. Poverty level is an index figure. The income factor for a nonfarm family of four was $3,743 in 1969. The remaining factors defining the index are family size, sex and age of the family head, and farm-nonfarm residence.

5. Myles Boylan, Economics of the Community (New Jersey: Scott Foresman and Co., 1961), p. 177.

6. Alan K. Campbell and Donna E. Shalala, "Problems, Unsolved, Solutions, Untried: One Urban Crisis," in The States and the Urban Crisis, ed. by Alan K. Campbell (Englewood Cliffs, New Jersey: Prentice-Hall, 1970).

SECTION II

AIR POLLUTION

II.A Air Pollution (Center City vs. Suburban)

Air pollution has been an integral part of the center city so long that many of its residents hardly notice its presence. It has become a feature of the landscape, like stop lights. For the poor who reside in the center city, air pollution is another indignity that must be endured. It seems relatively minor, however, when compared to unemployment, crime, and discrimination.

This section will define air pollution, describe how it is measured, and compare center city and suburban differential levels of air pollution. This information will first show that air pollution is worse in the center of cities than in the suburbs, secondly it will examine the health effects of air pollutants in center city and suburban areas thirdly, the sources of air pollution, and finally, air pollution controls.

The Environmental Protection Agency (EPA) has designated six elements of the atmosphere as air pollutants.[1] Also, there are proposed Federal standards for airborne lead. These will be discussed in this report as a unique problem of the center city.

Air pollution is measured by monitoring both ambient air quality and point source emissions. Ambient air is chemically monitored in small stations placed around a city. Emission data are gathered from point sources, e.g. factories and mobile sources, automobiles, trucks, etc. Levels are measured directly by placing monitoring devices on the source or by estimating the amount of emissions from the amount and type of materials consumed, and the completeness of the combustion.

II.B Ambient Air Data

Daily and hourly ambient air data, averaged into monthly and seasonal means form the most accurate picture for analysis. When plotted on a regional map, ambient data can be used to compare center city and suburban air quality. The areas of highest population and industrial density, characteristics of the center city, have the greatest levels of SO_2 and particulates.

Similarly, analysis of mobile source data suggests a relationship between land use (residential and industrial density) traffic density, and levels of pollutants (carbon monoxide and oxidants).

The findings with respect to lead also appear to support the hypothesis of pollution differentials. Data indicate that annual levels of lead were higher in the more urbanized industrial and commercial areas than in residential and rural areas.

Comprehensive ambient air quality data from several stations within and outside the central city are rare for most cities. Data are needed over several years to provide a comprehensive picture, and operation of such monitoring locations is expensive. For cities without comprehensive ambient air monitoring systems, a diffusion model is a useful method of analysis.

Diffusion models most graphically demonstrate the center city-suburban differentials in air pollution. Diffusion models (see Appendix A) for sulfur oxides, particulates, and carbon monoxide in five American cities show consistently that the highest levels of air pollution are in the center of the city.

II.C Air Pollution Sources

There are thousands of sources of air pollution in every city. Each home heater, car, and factory contributes to air pollution. The great density of these possible polluters in the city results in the generation of over 60 percent of the total air pollution on only 2 percent of the land area of this country.[2] Sixty-seven percent of the carbon monoxide, 56 percent of the sulfur oxides, 54 percent of the nitrogen oxides, 63 percent of the hydrocarbons, and 53 percent of the particulates emitted are within center city areas.[3]

The primary source of air emissions is incomplete combustion of fossil fuels, e.g. petroleum and coal products. These fuels provide the energy that runs the cars and industries, and heats offices and homes. (Other sources include leakage and process losses.) Sources can also be categorized by the proprietors of the sources, including industrial, commercial, municipal, mobile, and residential.

II.C.1 Industrial Sources

Industrial sources can be broken down into two types:[4] heavy manufacturing process losses and large boiler emissions. Heavy manufacturing includes steel, cement, and paper pulp production. Nationally, they contribute a wide variety of emissions including 22 percent of the sulfur oxides, 26.5 percent of the particulates, 23.8 percent of the nitrogen oxides, 9.6 percent of the carbon monoxides, and 1.2 percent of the airborne lead. Industrial boilers emit two pollutants in significant quantities: 17 percent of the sulfur oxides and 11 percent of the particulates.

Commercial and institutional sources include retail establishments, public buildings, office buildings, and some light industries. Their pollutants originate primarily from space heating plants, which emit 3.6 percent of the sulfur oxides nationwide. The use of organic solvents by dry cleaning establishments results in the emission of 9.7 percent of the total hydrocarbons in the air.

II.C.2 Municipal Sources

Municipal sources include utilities and solid waste combustion. Power plants are one of the most significant sources, emitting 49 percent of the sulfur oxides, 20 percent of the particulates, and 23 percent of the nitrogen oxides. Incineration and open burning of trash is responsible for 2.5 percent of the nitrogen oxides, 7.8 percent of the carbon monoxide, 5 percent of the hydrocarbons and 3 percent of the particulates.

Mobile sources can be defined as anything that moves and uses a petroleum or coal based fuel as a power source. This includes cars, buses, airplanes, trucks, trains, boats and ships, and off-road vehicles. Their contribution is large, emitting 64 percent of the carbon monoxide, 51 percent of the hydrocarbons, 39 percent of the nitrogen oxides, 4 percent of the particulates, and 2.5 percent of the sulfur oxides. Photochemical oxidants are produced almost exclusively from the reaction of gasoline combustion emissions with NO_2 and sunlight.[5] The automobile, with its heavy use of leaded gasoline, is the source of 95 percent of the airborne lead.[6]

Residential heating units also add pollutants to the air. They emit approximately 5 percent of the sulfur oxides and 1 percent of the particulates. Table 1 summarizes air pollutants by their respective sources.

The percentages cited represent national distributions. However, pollutants are not evenly distributed over the country. Definite geographical tendencies are exhibited for some pollutants. Sulfur oxides have the most pronounced geographical bias, with 50 percent of this pollutant found in seven northeastern states: New York, Pennsylvania, Ohio, Michigan, Kentucky, Indiana, and Illinois. These concentrations are a result of the use of coal and residual fuel oil as the major source of heat and energy. Concentrations in Texas and Arizona are also high but these are due to sméltering plants rather than use of high sulfur fuels.[7]

Although particulates come from a great variety of sources, they are found in the heaviest quantities in coal burning areas. Such areas include older cities which have space heating units, and older coal burning plants for heavy industry.[8]

In contrast, mobile emissions follow the pattern of urbanization. Carbon monoxide is the best illustrator of this pattern. Carbon monoxide (CO) concentration has a linear relationship with population density. A densely populated, older center city in most cases has a greater number of automobiles per square mile than other locales. The center city as a transport nexus has been discussed by Duncan.[9] It has been estimated that Washington, D.C. maintains 4,000 registered automobiles per square mile.[10]

Western and newer cities, which have grown since the introduction of the automobile, have the largest per capita

TABLE 1

AIR POLLUTION SOURCES

Source	% of National SO_x	% of National Particulates	% of National CO	% of National HC	% of National O_3	% of National Pb	% of National NO_x
Industry	39	43.5	9.6	N/A	-	1.2	23.8
Commercial	3.6	-*	-	9.7	-	-	-
Municipal	49	23	7.8	5	-	-	25.5
Mobile	2.5	4	64	51	99	95	39
Residential	5	1	-	-	-	-	-

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*Minus sign (-) indicates negligible amounts.

emissions. In a sample of 28 cities in the nation (see Table 2) three of 10 cities with the highest CO emissions per capita per year were in the far west, three were in Texas, and two in the Midwest (Minneapolis-St. Paul and Kansas City). Lead, being roughly proportional to automobile emissions, also shows a Western bias. Of 27 cities with lead levels exceeding 2.0 ug/m^3, 15 are west of the Mississippi River, including four of the five cities with the highest levels.[11] Oxidant levels are higher in Western cities also. Of twelve cities measured for oxidant levels, five of seven Western cities had levels above .05 ppm on at least 70 percent of the days measured. None of the Eastern cities reached that level more than 63 percent of the days measured.[12]

The effect on the center city resident of these variations differs depending on the city. Those living in the old northeastern cities have the most serious potential effect. They live in older housing units with coal burning furnaces, the density of mobile emissions per square mile are higher, and they are exposed to generally higher levels of sulfur oxide producing industries and power plants than other areas of the country.

In contrast, people in cities such as Los Angeles receive less pollution per square mile because of the lower density. Secondly, they are exposed to lower levels of sulfur oxides because natural gas and low sulfur petroleum fuels are used. However, the Western cities with a high dependence on cars for transportation have the highest levels of carbon monoxide, oxidant, and ambient lead.

Each city has a unique combination of sources and thus a unique air pollution problem, but regional differences from fuel uses and development patterns are evident. These regional differences must be taken into account in preparing strategies to enforce uniform ambient air standards.

II.D Health Effects

The previous data suggest that air quality is worse in the center city than in the suburbs. But air quality should be understood in terms of its effect on the city resident. The most important effect is real and potential health damage to inner city residents living in the area of highest air pollution concentration. Unfortunately, few good studies have been done relating air pollution severity with illness in the center city.

Several studies indicate that air pollution is a factor in increased respiratory illness. Acute exposures to high levels of pollutants caused rapid increases in respiratory illnesses in Donora, Pennsylvania in 1948.[13] During that attack, levels of sulfur dioxide reached approximately 1,140 ug/m^3.[14] Forty-three percent of the population reported symptoms of respiratory distress. In fall 1966, the East Coast of the United States was subjected to heavy smog as

TABLE 2

CARBON MONOXIDE LEVELS OF 28 SELECTED CITIES

Carbon Monoxide (Tons/capita per year)			
Over 0.6	0.6 - 0.5	0.5 - 0.4	0.4 - 0.3
Los Angeles St. Louis Kansas City	Minneapolis-St. Paul Houston Denver San Francisco Dallas San Antonio	Philadelphia Washington Detroit Cleveland Seattle Dayton	Louisville Steubenville Pittsburgh Chicago Providence Buffalo Birmingham Milwaukee Indianapolis Boston Cincinnati Hartford New York

Source: U.S. Department of Health, Education, and Welfare, "Sources and Pollutant Emission Patterns," p. 21.

levels of sulfur dioxides rose to over 1,300 ug/m^3. During this intense pollution period the New York City death rate increased by twenty-four per day.[15]

Studies in Chattanooga, Tennessee[16] and New York City[17] show an increase among adults in bronchitis, coughs, and shortness of breath in areas with high levels of sulfur oxides, particulates, and nitrogen oxides. In the New York study, the percentage of women with chronic bronchitis in low pollution areas was 4.7 percent as compared with 11.6 percent of the women in high pollution areas. Only 11.5 percent of men in low pollution areas had bronchitis as compared to 18.4 percent of men in high pollution areas. In all cases pollution variables were prime explanatory factors.

Urban children also suffer from air pollution. A study done on Cincinnati school children[18] found that children in polluted areas performed 17.4 percent below those in unpolluted areas on ventilatory function tests.

Additional studies have measured increases in mortality rates as a function of high levels of pollutants.[19] In Chicago daily respiratory mortality increased as levels of SO_2 increased and socioeconomic level decreased.[20] The death rate for respiratory disease per 10,000 ranged from 4.3 in low SO_2, high socioeconomic areas to 12.5 in areas of high SO_2, low socioeconomic levels.

In Buffalo researchers found an association between levels of suspended particulates and deaths from cirrhosis of the liver (results were adjusted for alcohol dependency).[21] Deaths for white men over fifty ranged from 26 per 100,000 in low particulate, high economic status areas to 359 per 100,000 for white men over fifty in high particulate, low economic status areas. White women over fifty had a death rate of 11 per 100,000 in low particulate, high economic status areas to 69 per 100,000 in high particulate, low economic status areas.

Airborne lead contributes to high lead concentrations in the blood when combined with other lead sources such as food or water. Lead levels exceeding 80 mg per 100 grams of whole blood are toxic and can lead to severe anemia, brain and nervous system damage by inhibiting production of red blood cells. For center city children this is especially hazardous, as they are also deficient in iron (another necessary element for red blood cells) and are exposed to greater levels of oxygen inhibiting carbon monoxide. This combination of reactions can lead to anemia.[22]

A study of lead levels in children in low income neighborhoods of 27 cities[23] indicated that 9.1 percent of the children had blood levels of lead exceeding 40 mg per 100 grams of whole blood. Eighty percent of lead poisoning cases can be traced to lead paint consumption.[24]

Blood lead levels for adults differ between those living in the center city and those in the suburbs.[25] A study in Philadelphia compared blood lead levels of people living and working in the center city (downtown), those living and working in the suburbs, those living in the suburbs and commuting to the city, and policemen. Policemen, who are exposed to lead filled automobile exhaust more frequently than others in the sample, had the highest levels of lead in their blood. Downtown males had the next highest level of lead. Suburban men and women each had .013 mg, the lowest levels of blood lead. Actual lead concentrations are shown in Table 3.

TABLE 3

DISTRIBUTION OF SUBJECTS ACCORDING TO THE CONCENTRATION OF LEAD IN BLOOD--PHILADELPHIA

Lead in blood mg/100g	Suburban		Commuter		Downtown		
	Male	Female	Male	Female	Male	Female	Police
0 -0.009	6	14	5	1	2	4	0
0.010-0.019	14	39	17	5	12	24	17
0.020-0.029	3	2	16	1	37	9	70
0.030-0.039		3	4		12	3	22
0.040-0.049			1		3		4
Totals	23	58	43	7	66	40	113
Mean	0.013	0.013	0.019	0.015	0.024	0.018	0.026
Std. Dev.	0.005	0.007	0.009	0.004	0.008	0.007	0.006

Source: U.S. Department of Health, Education, and Welfare, Public Health Service, Division of Air Pollution, Survey of Lead in the Atmosphere of Three Urban Communities, by the Working Group on Lead Contamination, Public Health Service, Publication Number 999-AP-12 (Cincinnati, Ohio: Government Printing Office, 1965), figure 3, p. 76.

There has been little research on the psychological effects of air pollution with the exception of a few studies reporting indirect evidence of subtle behavioral change. For example, on days of high oxidant levels, more headaches are reported and decreased work productivity is often the result.[26] Carbon monoxide can cause psychophysical changes when blood levels of carboxyhemoglobin (COHb) reach 6.6 percent, a level not uncommon in driving or in many work situations.[27] At this level, vigilance may be impaired. A driver may not notice a traffic light or another car beside him, and his responses to stimuli are slower.[28] The implications for driving safety are obvious.

There are no studies on the effect of auto emissions on the pedestrian, but since pedestrians are exposed to similar or greater levels of pollutants, it is not unreasonable to expect reduced vigilance on their part also.

II.E The Application of Standards

The mandate of environmental control in the United States metropolitan areas should effectively halt the deterioration of the natural resources. The Federal authority designated to enforce the directive is the Environmental Protection Agency.[29] This agency has responsibility for the six natural environmental categories defined previously. Briefly, these are: air, water, solid wastes, pesticides, noise and radiation (including solar energy). The technique through which this agency enforces the directive of environmental control is through application of standards. These standards are then applied uniformly to geographic regions of the United States.

Air pollution legislation has been in existence since 1963. Other legislation passed in 1965, 1967, and 1970 have been added to form the present Clean Air Act. Each law tried a somewhat different approach to end air pollution. EPA can use national ambient air quality standards implemented on a statewide level, air quality regions, and abatement conferences to combat the problem of polluted air.[30]

The most recent and currently most emphasized approach is ambient air standards with state implementation plans. EPA has set primary standards and secondary standards for six pollutants: sulfur oxides, particulates, hydrocarbons, carbon monoxide, photochemical oxidants, and oxides of nitrogen. Primary standards are the maximum levels at which there are no health effects. Secondary standards are the maximum levels at which there are no "known or anticipated adverse effects."[31] A list of the primary and secondary standards is presented in Table 4.

The state pollution control agencies are responsible for reaching and/or maintaining these standards with a variety of methods. Their choices include emission standards, transportation controls, and land use controls. States had to submit plans to EPA in 1971 to spell out how they were to accomplish these goals by 1975. If these plans were not satisfactory to EPA, they were sent to the state agencies for revision. Should a state plan still be unsatisfactory, EPA will draw one up for the state. It is still the state's duty to enforce it. If necessary, in the view of the Administrator of EPA, the length of time needed to implement the state plan can be extended from three to five years.

An earlier (1967) section of the law set up air quality regions. These are political jurisdictions based on legal, meteorological, social, and topographical information as related to air pollution. They can be either interstate or intrastate. There is an implementation plan for each air quality region in the United States.

TABLE 4

THE DESIGNATED AMBIENT AIR PRIMARY AND SECONDARY STANDARDS

Pollutant	Primary Standard	Secondary Standard
Sulfur oxide	80 ug/m^3 annual arithmetic mean 365 ug/m^3 24 hour maximum concentration not to be exceeded more than once a year	60 ug/m^3 annual arithmetic mean 260 ug/m^3 24 hour maximum not to be exceeded more than once a year
Particulates	75 ug/m^3 annual geometric mean 260 ug/m^3 24 hour maximum concentration not to be exceeded more than once a year	60 ug/m^3 annual geometric mean 150 ug/m^3 24 hour maximum concentration not to be exceeded more than once a year
Oxidants	125 ug/m^3 1 hour maximum concentration not to be exceeded more than once a year	125 ug/m^3 1 hour maximum concentration not to be exceeded more than once a year
Carbon monoxide	10 mg/m^3 8 hour maximum concentration not to be exceeded 15 mg/m^3 1 hour maximum concentration not to be exceeded more than once a year	10 mg/m^3 8 hour maximum concentration not to be exceeded 15 mg/m^3 1 hour maximum concentration not to be exceeded more than once a year

TABLE 4 Continued

Pollutant	Primary Standard	Secondary Standard
Hydrocarbons	125 ug/m^3 3 hour maximum concentration (6 to 9 a.m.) not to be exceeded more than once a year	125 ug/m^3 3 hour maximum concentration (6 to 9 a.m.) not to be exceeded more than once a year
Nitrogen dioxide	100 ug/m^3 annual arithmetic mean 250 ug/m^3 24 hour maximum concentration not to be exceeded more than once a year	100 ug/m^3 annual arithmetic mean 250 ug/m^3 24 hour maximum concentration not to be exceeded more than once a year

Source: Environmental Protection Agency, "Environmental Protection Agency: National Primary and Secondary Air Quality Standards." Federal Register, XXXVI, No. 21 (Washington, D.C.: Government Printing Office, 1971), 1502-1504.

An abatement conference is one form of control for specific pollution problems. These conferences must be requested by the governor of the state or states involved, the state or interstate air pollution agency, or the municipal authorities in the area with the consent of the governor(s) and air agencies involved. Conferences are informal hearings, open to the public, and must have participation from all interested parties. The hearing board, consisting of representatives from the Federal, State, and local levels, issues a report to the Administrator of EPA. He must then make a recommendation and wait at least six months. If his recommendation is not complied with he may then call a formal hearing. If his recommendations from the formal hearing are not acted upon in another six months, he can turn the case over to the Justice Department for prosecution.

There are no Federal emission standards for sulfur oxides, particulates, hydrocarbons, carbon monoxide, oxidants, and oxides of nitrogen from stationary sources. However, the Federal government does regulate hazardous emissions from stationary sources. These are defined as materials for which there is no ambient level, and that can cause an increase in mortality or serious, incapacitating disease. Hazardous emissions may be regulated in a variety of ways. For example, proposed EPA standards prohibit and prescribe certain application and filtering procedures for asbestos. Another method is to prescribe monitoring techniques along with emission standards. This has been done for beryllium and mercury.[32] These standards apply only to new sources.

EPA has jurisdiction over motor vehicles and other mobile sources. Under the 1970 amendments to the Clear Air Act, all light duty vehicles must have a ninety percent reduction of their 1970 emissions of carbon monoxide and hydrocarbons by 1975 and a ninety percent reduction of their 1971 emissions of oxides of nitrogen by 1976. The Administrator can regulate or prohibit additives in fuels if they are found to endanger the health or welfare of the public or if they inhibit the performance of any emission control devices. EPA has proposed limitations of lead and phosphorous in fuel. Lead in gasoline would be limited to 2.0 grams per gallon in 1974 and gradually cut down to 1.5 grams after January, 1977. EPA has proposed requiring one grade of gasoline that is lead free (less than 0.05 grams per gallon) and phosphorous free (less than 0.01 grams per gallon).[33]

New cars will be required to have emission control devices by 1975 and 1976. In addition, some states may require control devices on used cars. Several states may also restrict automobile traffic in the center city. Other mobile sources, such as trucks and buses, may also need emission devices.

States are experimenting with several methods to meet the ambient air standards of the Federal law. Fifty-four jurisdictions (50 states and 4 territories) have the legislative authority to adopt emission standards, limitations, and other means to meet the Federal standards. Fifty-one jurisdictions can abate air pollution emissions on an emergency basis. Only thirty-four states have the authority to require emission control devices on stationary sources. Seven states have the right to require inspection and testing of motor vehicles, and to use transportation and land control use measures.[34] (Environmental Quality, 1972.)

The effect of air pollution legislation on the center city will be influenced by the State or local government's previous involvement with air pollution control. For example, California and New York have had fuel and emission controls for several years, and thus industry and utilities will not be significantly affected by the Federal standards if they are already meeting the State standards. In States where such controls have not existed, these sources will be affected if they are the important sources of pollutants in their State.

It is not likely that most center city residents will be directly affected by pollution controls on their home or apartment furnaces. Their contribution to pollution is small nationwide. However, in cities where coal burning space heating units are used, some units may have to be changed or converted to burn a less polluting fuel.

Center city residents may use the law to sue pollution sources or government agencies if they believe the Clean Air Act is not being enforced in their area. While this procedure has drawbacks because it can be a time-consuming, expensive process, it gives the center city residents a direct input into controlling sources of pollution.

Like residents of the city, commercial sources contribute little to the total air pollution picture, but they may also have to change their space heating fuels in cities where coal burning units are common. Dry cleaners and other users of organic solvents might be specifically regulated in their emissions of hydrocarbons.

Municipal sources, defined here as public and utility sources,[35] will be greatly affected by the Clean Air Act, especially in areas using coal and high sulfur oil fuels for power generation. These sources will either have to change fuels or add stack emission control devices. Incineration of solid waste will have to be eliminated in many states in order to meet the Federal standards. This, of course, could complicate even further the problem of disposing of municipal solid waste.

For municipal and regional governments without a preexisting air pollution control agency, the Clean Air Act can help finance up to two-thirds of the creation of such an agency, and one-half of its yearly cost of operation. For joint agencies between two or more cities, the Federal government will pay three-fourths of the cost of initiating the agency, and up to three-fifths the cost of maintaining it. Interstate agencies can have their entire initial costs paid for two years, and three-fourths of their operating costs paid after that time.

Industrial sources will be affected, but the effect will differ among the states. As previously indicated, thirty-four states allow stationary source emission controls, and others may use land and transportation controls to discourage industrial uses of some areas of the city. To meet the state standards, some industries may not only need to invest in pollution control devices, but in new processes and machinery.

FOOTNOTES

1. Air pollutants: sulfur oxides (chiefly sulfur dioxide, SO_2, and sulfur oxide, SO), nitrogen dioxide (NO_2), carbon monoxide (CO), photochemical oxidants (usually measured as ozone, O_3), hydrocarbons (HC), and particulates or airborne non-gaseous materials. An explanation of the standards with respect to each of these will be presented later.

2. U.S. Department of Health, Education, and Welfare, Public Health Service, National Air Pollution Control Administration, "Sources and Pollutant Emission Patterns in Major Metropolitan Areas," by Guntis Ozalin, David V. Mason, and Clyde B. Marita (Durham, N.C., 1969), p. 19.

3. *Ibid.*

4. The following percentages for all sources were computed from Ozolins, et al, *Nationwide Inventory of Air Pollutant Emission* (1970), pp. 1-36, and *The Cost of Clean Air* (2nd ed., 1970), pp. 10-23. All percentages are aggregated nationally unless specified otherwise.

5. U.S. Department of Health, Education, and Welfare, Public Health Service, Environmental Health Service, *Air Quality Criteria for Photochemical Oxidants* (Washington, D.C.: Government Printing Office, 1970), p. 2-2.

6. U.S. Environmental Protection Agency, Office of Air Programs and Natural Environmental Research Center, *Health Hazards of Lead* (Research Triangle Park, North Carolina, 1972), p. 6.

7. U.S. Department of Health, Education, and Welfare, "Sources and Pollutant Emission Patterns," p. 26.

8. For example, before World War II, the city of Nashville, Tennessee used coal primarily for heating. Since then, most new homes use gas or electric heating. The contrast between the center city and the suburbs is striking: thirty-five percent of the city dwelling units used coal but only sixteen percent of the suburban units do. Of the 28,900 coal burning units in the Davidson County in 1960, 18,000 of them were in the prewar boundaries of Nashville. (*An Air Resource Management Plan for the Nashville Metropolitan Area*, 1965).

9. Otis D. Duncan, *Metropolis and Region* (Baltimore, Maryland: Johns Hopkins University Press, 1960).

10. U.S. Congress, Senate, Committee on Commerce, facts presented by James P. Alexander, Department of Environmental Services before a subcommittee of the Committee on Commerce, April 7, 1972.

11. U.S. Environmental Protection Agency, *Health Hazards of Lead*, p. 13.

12. U.S. Department of Health, Education and Welfare, Environmental Health Service, *Air Quality Criteria for Photochemical Oxidants* (Washington, D.C.: Government Printing Office, 1970).

13. U.S. Department of Health, Education, and Welfare, Environmental Health Service, *Air Quality Criteria for Sulfur Oxides* (Washington, D.C.: Government Printing Office, 1967).

14. ug/m^3 = micrograms per cubic meter.

15. U.S. Department of Health, Education, and Welfare, Environmental Health Service, *Thanksgiving 1966 Air Pollution Episode in the Eastern United States* by Jack C. Fensterstock and Robert K. Fankhauser, National Air Pollution Control Administration, AP-45 (Washington, D.C.: Government Printing Office, 1968).

16. U.S. Environmental Protection Agency, Air Pollution Control Office, *Air Quality Criteria for Nitrogen Oxides* (Washington, D.C.: Government Printing Office, 1971).

17. U.S. Environmental Protection Agency, Division of Health Effects Research, *Prevalence of Chronic Respiratory Disease Symptoms in Adults: 1970 Survey of New York Communities*, by Harvey Goldberg, John F. Finklea, Cornelius J. Nelson, Walter Steen, *et al.*, unpublished draft (Research Triangle Park, North Carolina, 1972).

18. U.S. Environmental Protection Agency, Division of Health Effects Research, *Ventilatory Function in School Children: 1967-1968 Testing in Cincinnati Neighborhoods*, by Carl Shy, C. J. Nelson, Ferris Benson, Wilson B. Reggan and Vaun Newill (Research Triangle, North Carolina, 1972).

19. Marvin Glasser and Leonard Greenberg, "Air Pollution, Mortality, and Weather," *Archives of Environmental Health*, XX (March, 1971), 334.

20. Mark H. Lepper, Nario Schisura, Bertram Carnaw, Samuel Andelman, and Leah Lehrer, "Respiratory Disease in an Urban Environment," *Industrial Medicine*, XXXVIII (1969), 36-41.

21. Warren J. Winkelstein, Jr. and Michael L. Gay, "Suspended Particulate Air Pollution," *Archives of Environmental Health*, XXII (January, 1971), 174-177.

22. Environmental Protection Agency, *Health Hazards of Lead*, p. 6.

23. U.S. Department of Health, Education, and Welfare, Public Health Service, *Childhood Lead Poisoning: A Thirty Neighborhood Survey*, by Roger S. Challop and Edward B. McCabe, (Unpublished Draft, Cincinnati, Ohio, 1972), p. 6.

24. Environmental Protection Agency, *Health Hazards of Lead*, p. 6.

25. U.S. Department of Health, Education, and Welfare, Public Health Service, Division of Air Pollution, *Survey of Urban Lead in the Atmosphere of Three Urban Communities*, by the Working Group on Lead Contamination, Public Health Service, Publication Number 999-AP-12 (Cincinnati, Ohio: Government Printing Office, 1965), p. 76.

26. U.S. Department of Health, Education, and Welfare, Public Health Service, Environmental Health Service, *Air Quality Criteria for Photochemical Oxidants* (Washington, D.C.: Government Printing Office, 1970).

27. Steven Horvath, Thomas E. Dahms, James F. O'Hanlan, "Carbon Monoxide and Human Vigilance," *Archives of Environmental Health*, XXIII (November, 1971), 343.

28. *Ibid.*, p. 343.

29. The history of the Environmental Protection Agency is contained in the brochure "Environmental Protection in Federal Activities" and the Annual Report of the Council on Environmental Quality, 1972.

30. J. Clarence Davies, *The Politics of Pollution*, Pegasus Books (New York: Western Publishing Corporation, Inc., 1970).

31. Clean Air Act, 42 U.S.C. 1857.

32. *Proposed National Emissions Standards for Hazardous Air Pollutants* (1971), pp. 9-28.

33. Council on Environmental Quality, *Environmental Quality* (Washington, D.C.: Government Printing Office, 1972), p. 163.

34. Council on Environmental Quality, *Environmental Quality* (Washington, D.C.: Government Printing Office, 1972), p. 46.

35. Utilities are defined as municipal sources because they are controlled by non-Federal governmental bodies in most areas of the country although they may be owned by private companies.

SECTION III

PESTICIDE POLLUTION

III.A Introduction

With the exception of local government spraying programs to maintain inner city foliage, the domestic use (or misuse) of pesticides is the predominant pollutant generator. Conditions in the center city which precipitate the use of pesticides are substandard housing, overcrowding, and garbage accumulation. This paper attempts to quantitatively describe the magnitude of the center city pesticide problem.

In 1970 the number of reported injuries attributed to pesticide usage was 4,045.[1] The number of deaths was nineteen.[2] Both of these statistics represent significant declines from the previous year. Unfortunately, data on exposure to pesticides is extremely sketchy. Moreover, the health effects of exposure to pesticides are not known or understood.

Pesticide abuse in the center city can be illustrated through the use of case studies. These studies were concerned with pesticide usage and storage characteristics of urban residents. To establish the existence of differentials, two studies will be reviewed in which pesticide residue concentrations in the blood were measured.

III.B The Kentucky Study

The Kentucky study[3] was a survey of urban households to determine pesticide usage and users habits. Some of the more alarming statistics: forty-three percent of the survey group stored pesticides in the kitchen, less than one-third of the survey group did not even bother to wash their hands before eating or drinking. There are other statistics worth mentioning. An overwhelming 81% (196 of 243) of the survey group said they used pesticides regularly. Ninety percent (218 of 243) used pesticides or professional pest control services. The average length of pesticide usage was 7-1/2 years. Only 15% of the population purchased pesticides from technical stores (nurseries, chemical dealers, feed and seed dealers), where proper instruction on their usage would be readily available. The remainder of the group was satisfied to purchase pesticides from general merchandise stores, food markets or drug stores.

The volume of pesticides used was greatest in the lower and upper income groups of the city. The lower income groups usage patterns were believed to stem mainly from pest problems related to poor housing and solid waste accumulation. Upper income usage patterns were believed to be influenced by a concern for protection of ornamental plants and shrubbery. Table 5 lists the pests reported sufficiently annoying to require pesticide usage.

TABLE 5

PESTS CONSIDERED SUFFICIENTLY ANNOYING TO REQUIRE CHEMICAL TREATMENT

Pest	Percent Reporting
Roaches	49%
Ants	32%
Flies	21%
Wasps	5%

Data indicating usage patterns in the home is shown in Table ~~3.2.~~

TABLE 6

USAGE PATTERNS IN THE HOME

Room	Percent Reporting Usage
Kitchen	63%
Basement	11%
Bedrooms	4%
Garage	4%

The South Carolina Study

The South Carolina Study[4] was conducted in Charleston, South Carolina using a sample group of 196 urban and center city families. The 121 white families in the study were from predominately middle class areas. The 75 non-white families were mainly from lower socioeconomic areas in the city. Among the usage characteristics investigated were frequency of application, pesticide hazards in the home and pesticide sources. In all cases, data was separated by race. A final portion of the study compared the prevalence of selected chronic diseases among families that were users or non-users.

The survey indicated that 89% made some use of pesticides. Of this user group, one-third utilized pesticides at least weekly. Usage was greater among non-whites than whites.

As in the Kentucky study, the majority of pesticide purchases were made in non-technical stores. Table indicates the source of pesticide purchases.

TABLE 7

SOURCE OF PESTICIDE PURCHASES

Source	Percent
Grocery Stores	60%
Drug Stores	15%
Feed and Seed Stores	15%
General Merchandise	10%

Differences in pesticide sources by race were not significant, and, hence, were not presented.

Pesticide mishandling was equally prevalent in both groups. Among the 174 user families 88% (153) utilized unlocked storage. Pesticides were stored within easy reach of children in 66% (115) of the cases. (Substantial morbidity and mortality among South Carolina children [particularly Negro children] due to acute pesticide poisoning was reported in the study. No figures were given.) Over one-half of the storage facilities were located near food or medicine. Finally, two-thirds of pesticide users did not wash their hands after usage or wear gloves during usage.

III.D The Florida Study

The Florida study[5] was conducted in Dade County, Florida during 1970-71 under the auspices of the Environmental Protection Agency, Division of Pesticide Community Studies (Contract FDA 70-11).

Residue concentrations of DDT, DDE and Dieldrin were measured and then compared with three social indicators: the Hollingshead Two Factor Index, population density and census tract median income. General classifications used in these indicators are shown in Tables 8-10.

Data used for analysis was tested to assure that no significant age differences existed between social classes. Also, persons under 20 years of age were eliminated from the study to minimize age dependency effects. Finally, it was assured that all persons had no recent or remote occupational exposure to pesticides.

Results of the study indicated that residue concentrations were associated with social class, i.e. greater concentrations were found in the poor. Average levels of DDT increased in those social classes reflective of poverty.

Similarly, average levels of DDE residues increased in those social classes reflective of poverty. This trend also appeared for both whites and non-whites.

Dieldrin concentrations also increased in those social classes reflective of poverty. However, this was only true for whites

Irrespective of the indicator of poverty that was used for comparison (i.e. Hollingshead Index, Census tract compaction Index or census tract median income) the results were the same. Average levels of residue concentrations increased in those social classes reflective of poverty.

Additional comparisons of concentrations within social classes (i.e. whites versus non-whites of the same class) yielded significantly higher mean concentrations among non-whites. Comparisons between sexes (i.e. white males versus white females of the same social class) yielded no signifi-

TABLE 8

HOLLINGSHEAD TWO FACTOR INDEX*

Classes I & II	Professionals
Class III	Skilled
Classes IV & V	Semi-skilled and unskilled

(Note: The Hollingshead Two Factor Index represents a weighted summation of the occupation of the head of the household and his level of education.)

TABLE 9

INCOME CLASSES

Class	Annual Family Income
I	$6000+
II	$5000 - 5999
III	$4000 - 4999
IV	$3000 - 3999
V	Less than $3000

TABLE 10

POPULATION DENSITY
(Census Tract Compaction Index)

Class	Density (Persons/acre)
I	Less than 20
II	20-30
III	31-40
IV	41-50
V	51-60

cant differences. Finally, variances (as measured by F-tests) were significantly greater in the poorer classes.

III.E The Hawaii Studies

A study similar to the Florida study was conducted in Hawaii (contract FDA-70-40) under the auspices of the Community Studies on Pesticides Branch of EPA.[6] Its purpose was to ascertain pesticide usage differentials between people residing in urban Honolulu and people living in the small village environment of Lanai. As in the Florida study, care was taken to assure that the sample group had no occupational exposure to pesticides. Interviews and blood samples analyzed for pesticide residues (DDT, DDE, Dieldrin, BHC) comprised the data collection phase of the study. Results of the residue analysis are shown in Table 11.

TABLE 11

SUMMARY OF PESTICIDE RESIDUE CONCENTRATIONS (PARTS PER BILLION) BETWEEN RESIDENTS OF LANAI AND HONOLULU

Residue (ppb)	LANAI			HONOLULU		
	Range	Mean	Std. Dev.	Range	Mean	Std. Dev.
DDT	0-20	3.27	2.40	0-27	4.56	3.05
DDE	1-130	16.7	14.3	1-107	16.1	11.1
Dieldrin	0-26	1.55	1.81	0-11	1.47	1.30
BHC	0-5	0.17	0.59	0-8	0.74	1.28

Analysis of variance at 0.01 level of significance indicated that the differences between samples (Lanai versus Honolulu) were significant for DDT and BHC concentrations. Differences were not significant for DDE and Dieldrin residue concentrations. (No sample sizes were given in the study. Therefore it is impossible to comment on the non-significant differences observed in the DDE and Dieldrin results.)

Residents of Honolulu had higher mean concentrations of DDT (4.56 ppb versus 3.27 ppb) and BHC (0.74 ppb versus 0.17). Standard deviations were also larger for DDT and BHC among the Honolulu residents. Residents of Lanai had higher concentrations of DDE and Dieldrin. However, these differences were not significant.

Although cited before, the statistics bear repeating. In the South Carolina and Kentucky studies, the percentage of urban residents using pesticides exceeded 80 percent.[7] Even with rigid usage guidelines, it is doubtful that this percentage could be significantly reduced. To try to regulate pesticide usage is to operate on symptoms rather than problems or causes.

In the short run, pesticide abuse can be curbed through educational programs, informative labelling and use and application laws. The long run solution is much more difficult. It involves eliminating the causes of pesticide pollution. Housing must be improved. Solid waste must be removed. Pesticides which are non-toxic to humans and that have no detrimental environmental impacts must be developed. Only then can significant inroads to pesticide pollution in the central city be made.

On the basis of the material cited one may draw the following conclusions:

- A majority of pesticide purchases are made in non-technical stores with little regard for consumer education. (Kentucky and South Carolina)
- The volume of pesticides consumed tends to be higher in the lower socio-economic classes. (Kentucky)
- There is an overall lack of respect for safe pesticide storage. (Kentucky and South Carolina)
- Pesticide residue concentrations in the blood are positively associated with poverty and its related ills. (Florida)
- Pesticide residue concentrations in the blood tend to be larger in urban environments than in small village environments. (Hawaii)

III.F Health Effects

Little information has been collected concerning the health effects of pesticide pollution in the urban environment. What data exists is extremely fragmented and indirect or inferential in character. Relationships between pesticide exposure and disease are ill-defined. Speculation rather than affirmation has been the key word in associating human health problems with pesticide use.

A study examining the health effects of household pesticide usage was recently undertaken in Oahu, Hawaii.[8] This study examined the relationship between chronic exposure to household pesticides and patients with medical histories of asthma, chronic bronchitis and sinusitis. A second study performed two years later on a sub-sample of the original study indicated a significant correlation between frequent use of insecticides and respiratory impairment.

In the Hawaii study, people who used pesticides once a week or oftener were classified as heavy users. Light users were classified as those that used pesticides less than once a week. The original study was made up of forty-four family units who were heavy users and forty-six family units who were light users.

Results of the study indicate that 26.3 percent (99 of 376) of the heavy use group reported having asthma, chronic bronchitis or both. Only 18.6 percent (61 of 328) of the light use group reported having the same health problems. Sinus trouble was also reported significantly more often in the heavy user group.[9]

The results of the sub-sample study are even more revealing. One hundred forty-two adults were analyzed with respect to respiratory impairment according to the AMA rating scale and their usage of insecticides. The AMA rating scale gives normative standards of respiratory performance based upon age, sex and height.[10] Pesticide usage patterns were classified as consistently heavy use (A), no use to heavy use (B), daily use to light use (C), and consistently light use (D). Usage patterns were based upon the previous two years. Table 12 indicates the results of this study. Statistical comparisons of the heavy usage group (A+B+C) with the light usage group (D) indicated these results were significant.[11]

TABLE 12

NUMBER OF PERSONS BY PESTICIDE USAGE CHARACTERISTICS AND RESPIRATORY IMPAIRMENT CLASS

Usage Group	Classification	Respiratory Impairment Class			
		1-(85+%)	2-(70-84%)	3(55-69%)	4(L55%)
A	Consistent Heavy Use	16	19	9	6
B	No Use to Heavy Use	5	10	6	2
C	Daily Use to Light Use	6	7	6	1
D	Consistent Light Use	25	13	10	1
TOTALS (142)		52	49	31	10
A+B+C	Any Heavy Use	27	36	21	9
D	Consistent Light Use	25	13	10	1

The results of the Hawaian study were further improved by separating the smokers from the non-smokers in the sample group. By removing smokers from the analysis, any possible bias introduced by the health effects of smoking may be eliminated. Eighty-one persons in the sample group did not smoke cigarettes. Seventy-one percent (35 of 49) of the heavy use group reported significant impairment. Only 44 (14 of 32) percent of light use group reported the same impairment. Comparison of heavy users (A+B+C) versus light users (D) again proved significant.[12] These results are shown in Table 13.

TABLE 13

NUMBER OF PERSONS (NON-SMOKERS) BY PESTICIDE USAGE CHARACTERISTICS AND RESPIRATORY IMPAIRMENT CLASS

Usage Group	Classification	Respiratory Impairment Class			
		1-(85+%)	2-(70-84%)	3(55-69%)	4(L55%)
A+B+C	Any Heavy Use	14	16	13	6
D	Consistent Light Use	18	8	6	0
	TOTALS (81)	32	24	19	6

The final part of the Hawaiian study compared pesticide usage characteristics over the past two years with persons exhibiting current symptoms of asthma, chronic sinusitis, chronic bronchitis, and perennial nasal allergy. The study was conducted with a sample group of 380 persons. Results are shown in Table 14. Twenty-three (62 of 268) percent of heavy users reported symptoms of the chronic diseases being considered. This contrasts with only 9.9 (11 of 112) percent of the light users reporting the same symptoms. Again, statistical comparisons between consistently heavy users (A+B+C) versus consistently light users (D) proved significant.[13]

TABLE 14

RESPIRATORY SYMPTOMS AND HOME INSECTICIDE USE

Usage Group	Classification	Number of Persons with Current Symptoms					
		Total	Asthma	Chronic Sinusitis	Chronic Bronchitis	Perennial Nasal Allergy	None
A	Consistent Heavy Use	156	16	6	5	18	111
B	No Use to Heavy Use	50	3	3	0	5	39
C	Daily Use to Light Use	62	2	1	4	4	51
D	Consistent Light Use	112	1	1	0	9	101
	TOTALS	380	22	11	9	36	302
A+B+C	Any Heavy Use	268	21	10	9	27	202
D	Consistent Light Use	112	1	1	0	9	101

General conclusions for the Hawaii study are (1) respiratory impairment, as measured by the AMA scale, was shown to be positively related to heavy pesticide usage; and (2) the existence of symptoms of certain chronic diseases was shown to be positively related to heavy pesticide usage.

These type of conclusions, however, are only scratching the surface of a very complex problem. Age, sex, diet and a myriad of other socio-economic variables affect the pesticide disease causal relationship. The same study undertaken in Oahu could be done in another area and yield totally different results. For example, the earlier referenced South Carolina study compared the prevalence of selected chronic disease among families that were users or non-users of pesticides. Their results for asthma, the only disease common to both studies, indicated no significant difference between pesticide users and non-users and existence of the disease. In fact, the study found no significant difference between users and non-users for any of the eight chronic diseases considered.[14] Results of the South Carolina study are shown in Table 15.

Due to the significant lack of knowledge in pesticide toxicology, it is fruitless to try to describe any uniform relationships between pesticide exposure and human health. The Mrak Commission[15] report uses over 200 pages to describe the effects of pesticides on man. To use any less, simplifies the problem beyond recognition. Present research is considering the possible effects of pesticide exposure in "genetic material (mutagenesis), effects on reproduction, including malformations in the fetus or newborn infant (tetragenesis) and increasing the incidence of various forms of cancer (carcinogenesis).[16] While there is no real evidence of detrimental effects of pesticides on human life, the fact that pesticide exposure on lower forms of mammals produces adverse effects, is a definite cause for human concern. It can only be considered a form of preventive medicine to limit pesticide usage among humans. The necessity for limitation in urban areas becomes more acute when overall inner environmental conditions are considered.

III.G Pesticide Regulation

The Environmental Protection Agency exercises pesticide regulation through the means of (1) The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as amended, (2) Section 403(c) of the Federal Food, Drug, and Cosmetic Act (FFDCA), as amended, and (3) the Clean Air Act (CAA) of 1970. The major points of these acts are enumerated below:[17]

- All pesticides that are shipped through interstate commerce must be registered with EPA.

TABLE 15

COMPARISONS OF THE PREVALENCE OF SELECTED CHRONIC DISEASES AMONG FAMILIES THAT WERE USERS OR NON-USERS OF PESTICIDES

Disease	Users (172)	Non-Users (22)	Comparison*
Anemia	2 %	9 %	NSD
Asthma	7 %	9 %	NSD
Cataract	6 %	14 %	NSD
Diabetes	13 %	5 %	NSD
Emphysema	3 %	0	NSD
Glaucoma	2 %	0	NSD
Liver Disease	0	0	NSD
Peptic Ulcer	5 %	0	NSD

NSD = No Significant Difference

* The most plausible reason for the lack of relationship in this example is probably medical in nature, i.e. pesticides have little impact in causation or aggravation of the diseases in question. In the cases of asthma and emphysema, both of which are respiratory system related, no comment can be made. It is possible that lack of data prevents any inference from being made.

- Pesticides cannot be approved for sale without manufacturers evidence concerning the purpose, toxicity and effectiveness of the substance.
- All pesticides approved for sale must be labeled clearly indicating ingredients, methods of application and safety precautions to be observed.
- EPA may halt the interstate shipment of any pesticide product if it is found to present a hazard to the public.
- EPA may terminate the production and use of any pesticide within thirty days notice (termination may be appealed).
- EPA establishes pesticide residue tolerance levels on raw food stuffs shipped through interstate commerce.

Other Federal activity can be summarized as below:[18]

- The Federal Trade Commission may regulate the advertising of pesticides.
- The Department of Transportation may regulate the shipment of pesticides through interstate commerce.
- The Food and Drug Administration may monitor food for the existence of economic poisons.
- The Department of Agriculture may prevent the introduction of pests into the United States and may engage in other activities relating to the control and spread of pests.

At the present time, there is a bill before Congress (H.R. 10729) to strengthen pesticide regulation and control. The bill, authored by the Council on Environmental Quality, was rewritten by the House Agriculture Subcommittee and severely weakened. As of August 18, 1972, this bill was pending before the Senate Commerce Committee. The major provisions of this bill are listed below.

- EPA would have the authority to restrict pesticide usage by classifying and categorizing them (e.g. restricted use, use with permit only).
- EPA would have the authority to regulate the disposal and storage of pesticides and pesticide containers.

- The bill will simplify procedures for suspension and cancellation of pesticides.

In addition to Federal activity, state governments are also trying to regulate pesticide consumption. For the most part state legislation has been oriented along the same lines as Federal legislation: Labelling, regulations on use, and listing of acceptable compounds.

III.H Federal Legislation and Pesticides

Federal legislation does not address itself to the center city pesticide pollution problem. The provisions of labelling, registration, and approval for sale are very lax.

When studies indicate that a large majority of pesticide users purchase compounds from non-technical sources, it indicates little regard for the selection of the proper compound on the part of consumers.[19] If labels were read and heeded, labelling could help solve this problem. However, considering the overall lack of consumer awareness in lower socioeconomic groups, labelling products and then allowing free choice in selection is a self-defeating act. If the labels are not heeded, labelling is not a real solution.

Additional indicators of total disregard for labelling would be the prevalence of hazards among pesticide users in South Carolina.[20] Also, the Kentucky survey indicated that most usage in the home was in the kitchen, proximate to food and eating utensils.[21]

An additional problem with labelling is the language used. Many central city residents lack the education to read and understand the language employed in labelling. Also, many central city residents are Spanish speaking. Labels written only in English cannot possibly serve their purpose among this group.

Before a pesticide is approved for sale, it must be registered with EPA. Registration consists of testing by EPA and by the manufacturer in order to designate what the pesticide may be used for, in what proportions, etc. The results of these tests guide the labelling decisions. Unfortunately, very few of the required tests pertain to environmental impact or health implications. Test requirements encourage the development of multi-use rather than single-use pesticides. It is only logical to assume the broad based multi-use compounds would tend to have a larger based environmental and health impact and thus make the environmental control more difficult.

To summarize, the present Federal pesticide legislation does influence the pesticide problem in the inner city; however, labelling can only be a solution if the labels are read and obeyed, and registration and approval for sale is only a solution if they are based on environmental and health considerations. The inner city pesticide problem cannot be improved significantly through present Federal legislation and action.

FOOTNOTES

1. U.S. Environmental Protection Agency, Office of Categorical Programs, Office of Pesticide Programs, "Urban Pesticide Usage," *Pesticides and Public Health* (Washington, D.C.: Government Printing Office, 1972), p. 75.

2. *Ibid*.

3. Kentucky Department of Health, Division of Environmental Services, Report of Pesticides Programs, *A Survey of Urban Households to Determine Pesticide Usage and Users Habits*, by Earl Edsel Moore (Unpublished Draft, Lexington, Kentucky, 1968).

4. Office of Categorical Programs, Office of Pesticide Programs, *South Carolina Study*.

5. Office of Categorical Studies, Office of Pesticides Program, *Florida Study*, 1971.

6. Office of Categorical Programs, Office of Pesticide Programs, *Hawaiian Study*, 1971.

7. Office of Categorical Programs, Office of Pesticide Programs.

8. Betsy P. Weiner and Robert M. Worth, "Insecticides, Household Use and Respiratory Impairment," *Hawaii Medical Journal*, XXVIII, No. 4 (1969), 283-285.

9. Results of the asthma/chronic bronchitis test are significant at the 0.05 level. The sinus test results are significant at the 0.01 level.

10. Classifications of the AMA scale are as follows:

Class	Percent of Expected Respiratory Function
1	85+%
2	70 - 84%
3	55 - 69%
4	Less than 55%

11. $p = 0.05$, $x^2 = 8.486$, 3 df.

12. $p = 0.01$, $x^2 = 14.782$, 3 df.

13. $p = 0.05$, $x^2 = 15.191$, 4 df.

14. Julian E. Keil, John F. Winkler, Richard L. Pietsch, Richard H. Gadsden, "A Pesticide Use Survey of Urban Households," *Agricultural Chemicals* (August, 1969).

15. U.S. Department of Health, Education, and Welfare, *Report of the Secretary's Commission on Pesticides and Their Relationship to Environmental Health* (Washington, D.C.: Government Printing Office, 1969), p. 229.

16. *Ibid.*, p. 235.

17. Environmental Protection Agency, Programs for the Inner City Environment, (Draft, March 17, 1972).

18. U.S. Environmental Protection Agency, *Toward a New Environmental Ethic*.

19. Keil, *et al.*, "A Pesticide Use Survey."

20. *Ibid*.

21. Kentucky Department of Health, *A Survey of Urban Homes to Determine Pesticide Usage*.

SECTION IV

WATER POLLUTION

IV.A Introduction

Water pollution is among the most pressing and widespread of the environmental problems. Any additions to the water which tend to degrade its quality so as to constitute a hazard or impair the usefulness of the water are considered pollutants by the Public Health Service. The Committee on Pollution of the National Academy of Sciences classifies water pollutants into eight categories.[1] The purpose of this discussion will be to show the increased water pollution problems associated with the center city. Two specific cases, Newark, New Jersey and New York City, will be analyzed. A Boston study and a survey study by the Bureau of Water Hygiene will exemplify drinking water problems.

IV.B Passaic River Study

Water in its natural environment, or ambient water, has been found quite polluted. A report on the extent of the pollution in the Passaic River was given by A. W. Bromberg, Chief of the Operations Branch of the Hudson-Delaware Basin Office of the Federal Water Pollution Control Administration (FWPCA), to an enforcement conference in 1969. A case study of the water quality of the lower Passaic River (mainstem between Newark Bay and its confluence with the Pompton River) was made based on data taken from 15 stations. This study indicates the disease producing potential of the water by the high coliform[2] bacteria counts. Almost all of the samples exceeded the permissible limits suggested by the standards. Total coliform counts were from 9,700 to 500,000 organisms per 100 milliliters (standard permissible is 10,000 organisms per 100 ml). The stations located specifically in the Newark Area show counts in the 100,000's. The fecal coliform levels increase very sharply to 50 and 60,000 organisms per 100 ml close to Newark (the fecal coliform standard is 2,000 per 100 ml).[3] Dissolved oxygen (DO) is measured as an indicator of pollution by organic wastes. In the vicinity of Newark the DO concentrations are consistently measured at one and two milligrams per liter (the standards are from 5-7 mg/l) which are the minimum allowable concentrations to support fishlife. This study (see Appendix A) shows why the Passaic River has been given the distinction of being "one of the most contaminated waterways in the world."[4]

Other sampling studies estimate the biochemical oxygen demand (BOD) loading of the Passaic River to be 17,000 pounds per day. This estimated loading is equivalent to the raw discharge of a population of 100,000 persons. The parameter of suspended solids was also estimated at a high level

(47,000 pounds per day).[5] The massive BOD loading, high coliform counts, heavy amounts of floating debris and very low amounts of DO show that the water quality conditions of the lower Passaic are below the Federal-state standards. The most severely polluted section of the river is near the city of Newark, where center city residents will be affected.

IV.C Hudson River Study

Similarly, the Hudson River shows the high degree of pollution affecting New York City. An ecological survey of the Hudson was done in 1968 by the Department of Environmental Medicine of the New York University Medical Center.[6] They found that high sulfates and nitrates together with low oxygen tip the balance between a healthy river and a noxious one producing hydrogen sulfide and ammonia gas. Coliform bacteria counts as high as 18,000 per 100 ml were found in July and August of 1967. The standard allowed for body contact recreation is 2000 per 100 ml.

A study restricted to the New York Harbor region was done in August of 1969. All of the six monitors show DO values of 2-3 mg/l (only 30 to 40 percent saturated) whether the measurements were taken at surface, mid, or deep levels. Total coliform counts reached values in the hundreds of thousands per milliliter showing long lasting pollution and potential health hazards; some samples were over 1,000,000 total coliform counts per 100 ml. The fecal coliform counts were found as high as 25,000/100 ml which strongly suggests gross contamination of the waters by the discharge of human wastes.[7] Table 16 gives a summary of the results. More complete data can be found in Appendix B.

TABLE 16

BACTERIAL SURVEY OF UPPER BAY--NEW YORK HARBOR

Coliform	Minimum	Maximum
Shallow samples (5 ft. from surface)	43×10^3	52×10^4
Deep samples (5 ft. from bottom)	22×10^3	25×10^5
Fecal Coliform		
Shallow samples	46×10^2	70×10^3
Deep samples	17×10^2	44×10^4

The Hudson River and Hudson Bay watershed represents a major population and industrial development. Sampling studies presented show significant amounts of pollution in these waters. G. P. Howells of the Department of Environmental Medicine of New York University Medical Center states in an interview July, 1972, "The lower Hudson River has the characteristics of an eutrophic,[8] brackish lake."[9] Pollution of the ambient waters near urban areas lowers the quality of the water for beneficial uses to center city residents.

Besides the ambient water, drinking water can become polluted and unsafe for consumption. Large cities may have a lesser quality of drinking water. The drinking water of a city generally leaves the treatment plant in an acceptable form, but depending upon the quality of the distribution system it may reach some people in a less than acceptable form. In old center city systems many supply pipes and drains are made of lead. "Under such conditions, water containing as much as 920 mg/l[10] of lead has been found in inner city areas, compared to an average of 20 ug/per liter elsewhere."[11] The Public Health Service drinking water standard for lead is "not greater than 0.05 mg per liter" (or 50 ug/l).[12] In July 1972, a survey was done in an older community of Boston on the quality of the drinking water in regards to trace metals. In 29 out of 54 homes the concentration of lead was found to exceed the standard. Some of the samples ranged from 0.060 mg/l to .253 mg/l.[13] A drinking water quality survey was also done in Chicago in 1968 by the Bureau of Water Hygiene. About 20% of the tap water samples were found to have higher concentrations of lead than water at the treatment plants, although only four samples exceeded the PHS rejection limit.[14] This indicates the use of lead pipes in the distribution system. When it is combined with corrosive or acidic water, the lead will be slowly dissolved into the water and can affect the health of the center city residents.

The Vermont Water Study

The National Community Water Supply Study surveyed 969 public water supply systems in the state of Vermont and in eight standard metropolitan statistical areas (SMSA). Each investigation considered three factors: tap water quality, adequacy of the facilities and operations, and status of surveillance and maintenance of the system.[15] It was found that the quality of drinking water is decreasing as the water supply systems are growing older and are not upgraded. "Forty-one percent of the 969 systems were delivering waters of inferior quality to 2.5 million people. In fact, 360,000 persons in the study population were being served waters of a potentially dangerous quality. . . . 56 percent of the systems evidenced physical deficiencies including poorly protected groundwater sources, inadequate disinfection capacity, inadequate clarification capacity, and/or inadequate system pressure. In the eight SMSA's studied, the arrangements for providing water service were archaic and inefficient. While a majority of the population was served by one or a few large systems, each metropolitan area also contained small inefficient systems."[16] Most of our municipal supply systems were built over 20 years ago. The population that many of them serve have increased rapidly and the systems do not have the capacity to serve the rising demands for clean water. The systems are obsolete because they were not built for the removal of toxic chemical or virus contaminants which increasingly pollute our waters. The drinking water quality and the ambient water in the center city have been shown to be of lower quality than some of the Federal-state standards for water quality and protection of health. The lower water quality may have detrimental effects on the health of the center city resident.

IV.E Industrial Water Pollution

Water pollution associated with industrialized and highly populated areas is caused mainly by municipal sewage and industrial wastes. A high density of industries in one area means that there will be more process wastes discharged into the nearby waters. In many of the large, old cities the waste water sewers are combined with the storm sewers and they overflow during storms and peak flow periods. Other major sources of water pollution are urban runoff, sediment from construction, oil spills, and ocean dumping. Drinking water quality is lowered by the maintenance of the municipal systems, the material of the pipes and the quality of the original source water.

Excessive deterioration of rivers, lakes and bays has now reached inexcusable magnitudes in urban settings. The sources of this pollution burden will be reviewed here showing that industries and municipal governments are contributing the largest amounts. Commercial, domestic and mobile sources will also be discussed as contributers to the pollution load. Unsafe drinking water is traced to inadequate municipal distribution systems.

Industrial process wastes are contributing the largest amounts of pollutants to our nation's waters. They produce 13,100 billion gallons of waste per year which includes massive amounts of suspended solids and BOD. An annual amount of 22 billion pounds of BOD load is being generated by industries, one-fifth of which is discharged to municipal sewers.[17] Between 1957 and 1968 the industrial BOD generation increased 200 percent while the growth in industrial production was only 60%.[18] This indicates that the type of technological processes used in production are a more important factor in causing pollution than just the amount of pollution. "The Federal Water Quality Administration in 1970 estimated that industrial discharges imposed an oxygen demand on waterways equivalent to the untreated sewage of 165 million people" (about eighty percent of the U.S. population).[19]

"There are at least 40,000 discharges of substantial amounts of industrial wastes directly into water courses in the U.S."[20] A definite lack of information exists on what the individual industries are actually dumping. It is known that a few major industries account for most industrial water use and most industrial water pollution. About 10,000 out of 300,000 manufacturing establishments in the U.S.

account for 90 percent of industrial water use.[21] Nine of the big contributors to water pollution can be identified: food and kindred products, paper, chemicals, petroleum, primary metals, transportation equipment, textiles, machinery (excluding electrical), and rubber and plastics.[22] The chemical and the primary metals have the most difficult effluents to treat in terms of the cost of the technology. The estimates for these costs in 1974 will be, respectively, $421 and $396 million dollars.[23] The paper industries are also large polluters especially when they use the sulfite process instead of the draft process in manufacturing. With an annual dumping of fifty trillion gallons of heated water, the electric power industries are also major polluters.[24]

IV.E.1 Industrial Water Pollution: New York City

New York City is a good example of pollution of a river associated with a highly industrialized area. New York's "Pure Waters Program" identified 225 industries as polluters of the Hudson River and Bay. All were included in the clean-up schedule. Out of the total number, 66 industries are in the New York City area and dump into the Hudson, Harlem and East Rivers, the Upper and Lower Bay and Kill Van Kull. The list of polluters contains dye works, food processing, printing, and smelting and refining. At the 1969 Enforcement Conference dealing with pollution of the Hudson River and its tributaries, only 4 out of the 66 New York City industries were reported as being on schedule in their clean-up processes.[25]

IV.E.2 Industrial Water Pollution: Newark

Along the lower Passaic River where Newark is located, 133 out of 182 outfall pipes belong to industries.[26] The city of Newark alone accounts for 41 of the industrial discharges as shown in Table 17. The quantities and properties of what comes out of these pipes are not precisely known. The industries located here include major water polluting types such as paper, petroleum, dyes, paints, chemicals, and electroplating. The city of Newark has over 90 percent of the electroplating industries located in the vicinity and 100 percent of the petroleum plants as shown in Table 17.[27]

The sewerage commission of Newark has pollution control responsibilities for discharges into the Passaic River and keeps violation records. In a review of these records up to 50 percent of the industrial violations detected each year were found to be committed by multiple offenders. Each year 25 to 30 major factories were cited several times for "accidental" violations. The list includes chemical companies, electroplating companies, dye corporations, paper mills, brewery, and meat packaging operations. But out of these

TABLE 17

OUTFALL PIPES IN NEWARK AND LOWER PASSAIC AREA
(Percent of Total in Newark)

	No. of Pipes from Industry	No. of Major Storm Sewers or Combined Sewer Overflow	No. of Misc. Storm Sewers and Surface Drains	Total No. of Pipes
Newark	41	5	3	49
Total on Lower Passaic River	133	11	38	182
% Total in Newark	31%	45%	8%	27%

Source: U.S. Department of the Interior, Hudson River Conference, p. 98. (The total number of pipes is for 13 Municipalities.)

TABLE 18

LOCATION OF FOUR CRITICAL POLLUTION INDUSTRIES
(Newark and Vicinity)

Municipality	Paper Mills	Petroleum Plants	Dye, Paint, Chemicals	Electro-plating
Belleville	2	--	10	1
Bloomfield	4	--	2	1
East Newark	--	--	4	--
East Orange	1	--	3	--
Suburban Total	7	--	19	2
Newark	24	8	103	28
Area Total	31	8	122	30
% of Area Total in Newark	77%	100%	84%	93%

Source: Beale, Pollution Control on the Passaic River, pp. 17-18.

violators not one has been assessed a penalty fine or been named in an abatement court action under state law.[28]

IV.F Municipal Wastes

Municipal wastes are the second largest source of water pollution after industries. The problems include municipal waste water plant effluents, "combined sewer"[29] discharges and urban runoff. The general situation concerning municipal plants is that 13,000 communities have sewer systems and of these 10 percent dump the wastes back into the rivers untreated and 15 percent provide only primary treatment.[30] In 1960 only 62.3 percent of the U.S. population was served by public sewers (27.5 percent had a septic tank or cesspool and 10.2 percent had non-water carriage or a privy).[31] In the 1970 census, about 70 percent of the total all-year housing had public sewer connections.[32] Many communities are still in need of sewage systems, while 25 percent of those that have them discharge partially treated or untreated wastes into receiving waters.

The large cities tend to be the oldest ones with the historically unplanned and presently overloaded sewer systems. They exhibit the largest numbers of combined sewers and the pollution problems that go with them. Table 19 is from an inventory of the percent and population size of communities with combined or separate sewers.[33] The inventory showed that 71 percent of the population groups of over 500,000 people have combined sewers or both separate and combined sewers. Most of the combined sewers are found in large communities, while 81.0 to 95.5 percent of the communities of less than 10,000 people have separate sewers.

The combined sewer problem can be seen in the highly urbanized area of New York City. The combined sewer overflow pollution load dumped into the Hudson in 1969 was 46 million pounds of BOD annually. The BOD load from municipal discharges in the area was 422 million pounds of BOD per year. It was estimated to decrease to 70 million pounds if the present treatment reached 90 percent BOD removal.[34] But New York City's plans are behind schedule for the building of waste treatment plants in the Pure Waters Program (1967-72). These plants were supposed to increase the city-wide BOD removal from 49 percent to at least 80 percent. More complete data is given in Appendix C.

The city of Newark, located on the lower Passaic River, is another example of a combined sewer system which causes pollution. More than 75 percent of its sewer system is over 100 years old and about 250 miles of its 500 miles of sewer pipes are combined. Together, age and inadequate maintenance result in inefficient operation and frequent breakdowns. Numerous illegal industrial connections into the collection system add to the total problem. The largest treatment plant of the lower valley and the Newark area offers only primary treatment and no disinfection. It is clear why the

TABLE 19

PERCENT OF EACH TYPE OF SEWER, WITHIN POPULATION GROUPS

Population Size Groups	*Percent of Communities With --		
	Separate Sewers	Combined Sewers	Both Separate and Combined Sewers
Under 500	95.5	3.5	1.0
500-1,000	90.2	7.6	2.2
1,000-5,000	85.5	10.3	4.3
5,000-10,000	81.0	10.4	8.6
10,000-25,000	78.3	13.2	8.5
25,000-50,000	71.3	13.9	14.8
50,000-100,000	65.8	22.4	11.7
100,000-250,000	52.4	22.6	25.0
250,000-500,000	58.3	19.4	19.4
Over 500,000	27.3	31.8	40.9
TOTAL	85.2	9.7	5.1

*Percent of reported cases.

Source: U.S. Federal Water Quality Administration, _Municipal Waste Facilities, Statistical Summary, 1968 Inventory_ (Washington, D.C.: Government Printing Office) Table 20, p. 35.

Passaic River is so heavily polluted. One estimate of the extent was that 70 percent of the Passaic's BOD is caused by the Newark sewer discharge.[35] Similarly, during a nine-month study in Chicago, Illinois, 31 storms occurred and the total BOD discharged to the stream was 278,000 pounds. The average total BOD overflow load was calculated to be 46,900 lbs/day.

The third category of municipal water pollution is urban runoff which is considered a dispersed or non-point source. This less obvious pollution enters receiving waters through separate storm sewer discharges during periods of precipitation, thaw, or runoff and drainage from other sources. The range of stormwater pollutants concentrations is very wide. Total coliform counts per 100 ml have been measured from 40 to 240,000 and suspended solids from 26 to 36,250 mg/l.[36] The dispersed pollution load should be considered along with the municipal and industrial point sources. For example, a study done of the runoff near Detroit indicated that BOD in separate stormwater discharges was generally about one-fifth of that observed in combined sewers. Total coliform densities were approximately one-tenth of those in combined sewers. Another study of street runoff from Washington, D.C. found that the average BOD concentration was 126 milligrams per liter and the average concentration of suspended solids was 2,100 mg/l. In meeting the future demand for municipal water supplies and sewage treatment, proper drainage sheds should also be planned.

Commercial and domestic sources of water pollution are mainly indirectly responsible for their pollution. Businesses, offices and residences are hooked up to municipal sewage systems and those systems cause pollution. Sediment in urban runoff is a pollutant which is traceable to the practices of a construction firm. Non-agricultural land disturbing activities that are concentrated in urban areas yield enough sediment to add to water pollution levels. During construction when the land is exposed to erosion some form of sediment control is needed.

The mobile sources of water pollution in the U.S. which are of the most concern to urban areas are oil spills and ocean dumping. Oil spillage has been ranked as the second most important source of pollution in the Chesapeake Bay by Dr. Pritchard, director of the Chesapeake Bay Institute at Johns Hopkins University. (First is domestic sewage at nine million gal./day.) The number of oil spills documented by the Coast Guard in 1970 off the coast of Maryland and Virginia was 145 amounting to 1,058,896 gallons of spillage. The Chesapeake Bay is one of the major trans-shipments routes along the East Coast used by the petrochemical industry.[37] The deliberate dumping of sludge and garbage into the ocean pollutes harbors near large population centers. The marine life in them is crucial to the fishing industry which provides jobs and food for the people of the city.

Industrial waste accounts for most of the dumping. Solid waste, sewage sludge and dredge spoil are also significant pollutant sources.[38]

IV.G Health Hazards

This discussion considers the health hazards which close public beaches and those health hazards found in poorly treated drinking water. These hazards affect the center city resident by causing a lack of water recreational resources and by lowering the quality of drinking water.

IV.G.1 Beach Areas

Many beaches near urban areas are closed because of hazardous pollution counts. These include beaches in the Hudson River and Bay, the Chesapeake Bay and the Lake Erie area. "Fifty years ago, 540 of New York City's 575 miles of waterfront were deemed unfit for swimming. Almost none of the shoreline has been reclaimed. Less than twenty miles of beaches exist where the water is considered clean enough for swimming--and the quality at these beaches is highly questionable." Beaches at Coney Island and Staten Island were rated as either conditionally unsafe or unsafe.[39] A study of New York Harbor in 1969 showed that bacteria discharged at Robbins Reef (discharge point for a waste treatment plant) can reach the beaches of Coney Island and Staten Island within six hours. A minimum of 20,000 organisms per 100 milliliter of coliform bacteria can survive the six-hour exposure.[40] The maximum allowed for body contact recreation is 2,000 organisms per 100 ml. This indicates that pathogenic organisms which may be in the waste water can cause a health hazard for center city residents using the lower bay for recreation.

Similar hazardous conditions were found in the Washington, D.C. area in a study done by the Department of Microbiology at the Georgetown University School of Medicine in 1970.[41] Coliform counts in the Potomac River consistently exceeded 100,000 MPN (most probable number) per 100 ml and fecal coliform levels exceeded 10,000 MPN/100 ml. The study indicates a clear danger to public health as coliform counts should not exceed 2,000 MPN/100 ml. for swimming and 10,000 MPN/100 ml for boating and shore recreation. Dr. Falkow of the Georgetown University School of Medicine recommended that water contact recreation on the Potomac be immediately prohibited because of the health hazard. The waters near urban areas have been found to be extremely polluted and unhealthy. Center city residents are without easy access to water recreational resources as the closest waters are unsafe.

IV.G.2 Drinking Water

Poor quality drinking water can be traced to inadequate municipal water treatment facilities, old distribution systems, and unprotected water supply sources. The older supply systems and treatment plants are subject to more frequent breakdowns and contamination entering in from inadequate chlorination. Lead may be dissolved in the water from older lead pipes and joints. Metals and organic chemicals reach the water supplies from industries and may not be completely removed by present treatment processes.

Drinking water from old, center city distribution systems can also be considered unsafe. The Public Health Service Drinking Water Standards define health hazards as "any conditions, devices or practices in the water supply system and its operation which create, or may create, a danger to the health and well being of the water consumer."[42] Harmful substances in the water as well as poor maintenance of and inadequate treatment in the water supply facilities constitute health hazards. Potential health dangers exist in inefficient supply systems which do not or cannot remove harmful substances such as bacteria, viruses, heavy metals and organic chemicals from the drinking water. Physical deficiencies were found in fifty-six percent of the 969 systems studied in the Community Water Supply Study (CWSS).[43]

Individual tap water samples were taken during the CWSS in 1970 and analyzed according to the PHS Drinking Water Standards. Thirty-six percent of the 2,600 samples contained one or more bacteriological or chemical constituents exceeding the limits. Nine percent contained bacteriological contamination evidencing a potentially dangerous quality of water. Thirty-six percent exceeded at least one of the chemical limits. Eleven percent exceeded the recommended organic chemical limit of 200 parts per billion.[44]

A potential problem exists with bacterial contamination as public distribution and treatment facilities become older. Bacteria can enter at the source of the water supply or later in the distribution systems. Cases of system failures and the resultant outbreak of waterborne diseases show the lack of adequate treatment facilities and their maintenance.

In Riverside, California (in 1965) 16,000 people were affected by an epidemic of acute gastroenteritis in which seventy people were hospitalized and three died.[45] Another attack of gastroenteritis occurred in 1968 in Angola, New York because of a failure in the disinfection system. The town uses the same lake for sewage and drinking water.[46] Other cities such as Buffalo, New York and Fall River, Massachusetts have frequently instructed their residents to boil all their drinking, cooking and washing water because of bacterial pollution.[47]

Other than the deterioration of water supply facilities, a potential health hazard exists in the water pollutants which cannot be removed by regular processes. Three types of these pollutants are viruses, heavy metals and organic chemicals. Viruses can survive chlorination processes better than vegetative bacteria. The occurrence of waterborne hepatitis indicates the potential danger of such episodes if conditions favor the virus population. A total of 53 waterborne outbreaks of infectious hepatitis were reported in the literature in this century.[48] A recent example happened in 1969 in Worcester, Massachusetts when sixty percent of the Holy Cross College football team was stricken with infectious hepatitis as a result of ineffective cross-connection control procedures.[49] Better techniques of water treatment are needed to insure elimination of viruses from drinking water.[50]

IV.G.3 Toxic Substances

Heavy metals such as lead and mercury constitute another health hazard to center city residents. Toxic effects occur from an accumulation of the metals in the body resulting from exposure to excessive amounts (in air, water, food and/or paint). More cases of lead poisoning have been discovered in older sections of cities than elsewhere.[51] Although the largest source of lead exposure is probably lead based paint the existence of lead concentrations in drinking water must also be considered a severe problem.[52] The major problem with heavy metals in water treatment processes is removal difficulties. Existing procedures are not always effective in removal of these substances.

The addition of organic chemicals such as DDT to water resources is growing in frequency all the time. Newer chemicals are being developed and added to the environment, while the effect of these chemicals has not been fully analyzed to determine their toxicity to people. An example is PCB's (polychlorinated biphenyls) which are used in industrial coolants. It is estimated that about 300,000 gallons per year of PCB materials are presently used by Michigan industries and that there is a potential market of about one million gallons per year.[53] Most of this is dumped in waste effluents into receiving waters. More research needs to be done on the environmental and health effects of these new chemicals as well as better methods of removing them from drinking water.

IV.H Control of Water Pollution

The Environmental Protection Agency represents the Federal government's role in the abatement of water pollution. It offers central administrative support to the individual states in the establishment of their own standards. Pollution controls on interstate and navigable waters can be directly enforced by EPA. There is a Federal system of "matching grants" to municipalities for the construction of waste water treatment works. Recently a bill to set minimum national standards for drinking water was passed. The present laws will be reviewed along with three which are now before the legislature.

The Federal laws to abate water pollution follow two methods: (1) That of an enforcement conference, and (2) that of construction grants for waste treatment plants. Both of these are in conjunction with the states. Direct Federal responsibility exists for interstate and navigable waters and also for cases where the interstate sale of shellfish suffers from pollution. Only if a governor or state agency requests the assistance may the Federal government take action for intrastate pollution. For example, the conferences on the Hudson River began in 1965 because of requests from the governors of New York and New Jersey and also because survey studies showed interstate pollution.

The idea of enforcement conferences to end water pollution began in 1956 with the Federal Water Pollution Control Act. After hearing testimony from the polluters recommendations are made along with a clean-up schedule. The states are given the responsibility of enforcing the recommendations. After more hearings and warnings with six months time limits the polluters may be taken to court by the Federal government. This is a long and complicated process. Since the 1956 Act, 59 conferences have been initiated and none of these has ever been officially "closed." Instead, they have been reconvened several times, the Potomac Conference at least five times. Up to 1971, only four cases had proceeded to the hearing board stage and only one had been taken to court. The suit against St. Joseph, Missouri began in 1960 and has not closed yet.[54]

In an attempt to expedite the enforcement procedures, the Water Quality Act of 1965 provided for the water quality standards program. This Act requires the individual states to draw up their own standards, which when approved by EPA become the Federal-state standards. The procedure for the standards program involves three steps. First, the states hold public hearings to set stream classifications for waters within their boundaries. This is done according to the use of the water, e.g. swimming, boating, etc. Second, the appropriate criteria are set to meet the classifications of water usage. For example, the criteria for coliform bacteria might be a permissible level of 10,000 organisms per 100 milliliter in a public water supply and a maximum level of 1,000 per 100 ml in water used for body contact recreation. The third step of the procedure is the setting of the implementation plans. This is a schedule for actions to be taken by the polluters to enable the waters to meet the Federal-state criteria. The schedule might include dates for planning, starting and completing the construction of a municipal waste water treatment plant. The enforcement procedure for the standards program rests initially with the states. But if the polluters are not meeting their schedule in the standards (most of the final compliance dates are prior to 1975) EPA may issue a 180 day notice. This gives the polluter six months to agree to voluntary action or be taken to court.[55]

The most recent law, The Water Quality Act of 1970, includes a section on the control of oil pollution placing this problem under Federal authority. Fines of up to $10,000 are required for discharges of oil from vessels, and on-shore or off-shore facilities. The owners or operators responsible for the pollution are liable for up to $14,000,000 for the cost of the damages and removal of the oil.

Federal water pollution abatement through grants for the construction of waste treatment plants began in 1956 when funds were first authorized. More funds were authorized in 1965 and in the Clean Water Restoration Act of 1966. Under the present law, grants between 30 and 55 percent of the approved construction cost are available from EPA. Since 1957, the Federal government has paid considerable amounts of money for treatment plants.[56] In theory this helps abate industrial pollution because industries may pay to hook up to municipal plants to allow treatment of their effluents. Federal grants for manpower training to schools and scholarships to individuals for training in water quality technology are also available. Funds are also provided for regional planning agencies which draw up the implementation programs.

An anti-pollution tool that was already in existence but not being used as such is the Rivers and Harbors Act of 1899 (Refuse Act). It provides for fines of $2,500 per day for discharging refuse or waste, except municipal sewage, into navigable waters without a permit from the Army Corps of Engineers. The law was brought back into use in 1970 by an executive order. A permit program was instituted to be run jointly by the Army Corps of Engineers and The Environmental Protection Agency. The states are also given a say in whether a permit is to be issued or denied until the discharge receives treatment. One unique provision of the law is that any person who gives information which "leads to a conviction" is entitled to one-half the fine. The Act has been tested in a court and found to be a useful tool against unauthorized discharges.

Presently the permit program is being held up because of a court case (Kalur v. Resor, December 1971) which says that an environmental impact statement must be filed for each permit issued. Section 102(2)(C) of the National Environmental Policy Act requires "all agencies of the Federal government" to prepare environmental impact statements on major actions significantly affecting the environment. Congress did not intend section 102 should change existing agencies that "already have important responsibilities in the area of environmental control." The Council on Environmental Quality issued guidelines which limit exemptions from the 102 process to "environmental protective regulatory activities taken or concurred in by" EPA. But NEPA itself contains no specific guidance on this point. As a result the Federal district court's decision in the Kalur case has held up the permit program established under the Refuse Act. There is now a backlog of over 20,000 permit applications on existing refuse discharges which are awaiting further decisions.[57]

The most recent method to control pollution is the idea of effluent limitations which is part of the proposed 1972 amendments to the Water Pollution Control Act. Effluent limitations are a more direct means of enforcement than the stream water quality standards, because they are easily applied to a specific polluting discharge. The new bill would require, by January 1, 1976, effluent limitations "of the best practical control technology currently available."[58] The bill even goes further to say that there shall be no discharge of pollutants by January 1, 1981; or else "limitations consistent with the best available demonstrated technology."[59] Publicly owned treatment works existent on January 1, 1976, or those approved for construction prior to June 30, 1974, must meet effluent limitations based upon a defined secondary treatment.[60] This difference between public and private sources was made in recognition that they generally have different types of effluents. If a private discharge is put into a public treatment system, provisions are made for "pretreatment standards."

The Federal and state governments will work together to establish the effluent limitations regulations along with the best "practicable" and the best "available" techniques. The economic, social, environmental and technological effects of achieving or not achieving the effluent limitations and the goals of no discharge by 1981 are expected to be considered. This will be in a report to Congress by the National Academy of Sciences and the National Academy of Engineering which is due two years after passage of the bill.

How does this bill relate to past legislations? First of all, the Water Quality Standards program according to the 1965 Act will still be continued "unless found to be inconsistent with the 1972 Act." The effluent limitations can be made more stringent if they are found inadequate to meet the water quality standards of the 1965 Act. Secondly, the Refuse Act Permit program will be changed. Under this bill there will be more Federal-state cooperation in issuing Federal permits. Most of the enforcement burden will be upon the states. The Federal government can only deny a permit if the discharge will affect the quality of the waters in another state. Overall, the enforcement procedures will be based upon discharge permits and effluent limitations with fines and/or jail sentences instead of the old conferences and 180-day notices.

The comprehensive new bill includes many other provisions. One calls for "user charges" which industries will pay for their use of a waste water treatment plant according to volume and strength of effluent. Public participation will be in the form of "citizens suits" against any person or persons in violation of the effluent limitations. Grant money is included for the construction of new waste treatment plants for amounts from 60 to 75 percent of the cost, depending on the state's share. Eighteen billion dollars for fiscal years 73-75 is asked for in the proposed law for the purpose of construction grants. Loans to small business concerns for water pollution control facilities are authorized in the bill to be made when the small business needs assistance. The Attorney General will "make a study of the feasibility of establishing a separate court or court system having jurisdiction over environmental matters." An Environmental Financing Authority (EFA) will be established under the supervision of the Secretary of the Treasury. The EFA will help the state and local governments in the financing of their share of the construction of waste treatment facilities.

The proposed Marine Protection and Research Act of 1971 provides for a permit system run by EPA to control ocean dumping. The Federal controls will be applied at the loading dock. No owner of a vessel may load waste which is to be discharged in ocean waters unless a permit has been obtained from EPA and the Coast Guard is notified of the exact dumping location. The permits are issued only if EPA concludes that the discharge of such waste in any ocean waters will not damage the ecology of the marine environment. The wastes which are included in this Act are dredge spoils, sewage sludge, solid waste, industrial wastes, construction debris and radioactive wastes. The area covered by the "ocean waters" is both the territorial waters within three miles of the shore and the high seas adjacent to the territoral waters as far as twelve miles out.

There are proposed amendments to the Public Health Service Act which will provide for the establishment by the Federal government of certain standards pertaining to drinking water and its sources. The bill provides for minimum national standards which will be implemented and enforced by the state and local governments. These proposed standards for the minimum quality of water allowable for drinking in the U.S. will include the maximum permissible levels for any chemical, biological, radiological or other contaminants. Before these standards, the Federal government only had authority over water supplies serving interstate carriers. The new law will allow Federal enforcement action when the states fail to do this. A hearing board may be called to examine the problem and to make recommendations. The violaters then have six months to one year to correct the drinking water contamination problem before the matter is referred to a court. Technical as well as financial assistance will be provided by EPA for state and local agencies in need. These amendments are still in Congressional subcommittees for discussion.

Provisions in the Federal water pollution laws will not affect the residents of the center city as direct generators of that pollution, but the residents may take action against the polluters. Under the Refuse Act of 1899 citizens may act as informers against industries which are discharging wastes without a permit. Employee protection is insured for any citizens acting as informers against their own employers for violation of anti-pollution laws. The informers are entitled to one-half of the imposed fine. Under the proposed 1972 amendments, citizens may sue public and private violators of the effluent limitations.

Municipal governments are responsible for the pollution caused by publicly owned waste treatment facilities, combined or separate sewer systems, and urban runoff. If they are presently found to be violators of the Federal-state water quality standards program, EPA first gives the states an opportunity to take action. When the state pollution control agency doesn't do this, the Federal government can call an enforcement conference or issue a 180-day notice to the municipality to abate the pollution. The usual route followed today is to issue a 180-day notice. During the 180 days an agreement may be reached on a program for pollution abatement. If not, the court will hear the case and makes its own recommendations. The polluter can then be fined or imprisoned for contempt of court.

Under the present law municipal governments are eligible for construction grants between 30 and 55 percent of the cost to treatment facilities. The remaining cost must be made up on their own (45-70 percent) at the expense of other much needed city programs.

The 1972 proposed law has a simpler means of enforcement. By January 1, 1976 all publicly owned treatment works must have secondary treatment for their effluents. When EPA determines a municipal plant is illegally discharging, the state agency is given thirty days to take action. EPA will then issue an order to the polluter or take him to court. Federal enforcement action can be in a civil court for a fine of $10,000/day of violation or in a criminal court for penalties up to $25,000 per day of violation and/or one year in jail.

Besides a faster and more direct means of enforcement, the new law would provide for construction grants of between 60 and 75 percent of the cost for waste treatment works. This leaves only 25 to 40 percent of the cost up to the municipal government. Federal money will also be provided for comprehensive planning by regional or interstate agencies (75 to 100%).

The passage of the Safe Drinking Water Act will mean enforcement of standards upon municipal water supply systems. Municipal governments will have to pay to upgrade their present systems and efficiency of treatment, or, pay to build all new systems. Federal money and technical assistance is offered to the municipalities to help meet conditions of the Act.

The proposed legislation may have direct effects upon certain industries. Building and highway construction will have to provide for sediment control programs which will increase construction costs. The cost of sediment control for housing construction programs is estimated at between $100 and $150 per structure. A total investment in this is estimated by CEQ for 1972 to 1980 to be $900 million.[61]

Industries which discharge wastes into interstate and navigable waters are presently subject to the same controls as municipal waste treatment plants. They must comply with the 1965 Water Quality Standards Program or be given a 180-day notice and then taken to court. The industry may be found discharging refuse without a permit and be illegal under the 1869 Refuse Act. If found guilty, the polluter must pay $2500 per day for the violation.

The new law will clear up the procedure to define deadlines for achieving certain effluent limitations. They are the "best practicable methods" by January 1, 1976 and no discharge or the "best available methods" of treatment by January 1, 1981. Enforcement of the law will rest with both state and Federal authorities. Federal action could take one of three approaches: court order, civil proceedings or criminal proceedings. The choice "presented" to the industry is to pay for the pollution controls or to pay court fines, plus the pollution controls if found in violation. Possible fines of $25,000 per day of violation are provided in the law.

The mobile sources which cause oil pollution are now liable for the costs of damages and clean-up under the 1970 amendments. This method will probably continue under the new proposed law. The choice for the oil transporters is to pay for safer vessels or to pay for the high cost of the damages which their pollution imposes upon the environment. The vessels which would dump refuse into the ocean (harbors and bays) will have to receive permits if the Marine Protection Act becomes law. The permits would only be allowed if EPA determined that the dumping would not damage the marine ecology.

FOOTNOTES

1. (1) Domestic sewage and other oxygen demanding wastes; (2) Infectious agents; (3) Plant nutrients, particularly nitrogen and phosphorous; (4) Organic chemical exotics, particularly insecticide, pesticide and detergents; (5) Other mineral and chemical substances from industry, mining and agricultural operation; (6) Sediments from land erosion; (7) Radioactive substances; Heat. From Hoch, p. 26.

2. Coliform bacteria are a group of bacteria often found in human wastes and their existence in the water indicates the possibility of finding more.

3. U.S. Department of the Interior, Federal Water Pollution Administration, _Proceedings of the Conference in the Matter of Pollution of the Interstate Waters of the Hudson River and Its Tributaries--New York, New Jersey_, 3rd Session (Newark, New Jersey, 1969), pp. 27, 81-85.

4. David T. Beale, _et al_, _Pollution Control on the Passaic River: A Report by the Center for Analysis of Public Issues_ (Princeton, N.J.: 1972), p. 22.

5. U.S. Department of the Interior, _Hudson River Conference_, p. 87.

6. _Ibid._, p. 34.

7. _Ibid._, p. 66. Data tables, maps and graphs are given in Appendix B.)

8. Eutrophication is the tendency of a body of water to fill up with debris or algae and degenerate into a swamp.

9. U.S. Department of the Interior, _Hudson River Conference_, p. 33.

10. One microgram per liter (ug/l) is equivalent to 10^{-6} grams per liter.

11. The Second Annual Report of the Council on Environmental Quality (1971), p. 196.

12. Public Health Service. _Drinking Water Standards, 1962_, PHS #956 (1969), p. 45.

13. Boston Trace Metal Analysis (unpublished data 1972) and _The Boston Globe_ (July 25, 1972).

14. Leland J. McCabe, "Trace Metals Content of Drinking Water from a Large System," Symposium on Water Quality in Distribution Systems, (Minneapolis: American Chemical Society, 1969).

15. U.S. Congress, House, Committee on Interstate and Foreign Commerce, Bureau of Water Hygiene, "Community Water Supply Study: Analysis of National Survey Findings," Safe Drinking Water (1970) in Safe Drinking Water Hearings, before the Subcommittee on Public Health and Environment of the House Committee on Interstate and Foreign Commerce (May, 1971), pp. 180-307.

16. Ibid., James H. McDermott, pp. 176-177.

17. Allen V. Kneise, "Lectures on the Political Economy of Water Quality Management," lecture presented at the University of California, Berkeley, Spring (1971).

18. Ibid.

19. Gladwin Hill, "Our Troubled Waters: The Fight Against Water Pollution," Public Affairs Pamphlet No. 462 (1971), p. 4.

20. Kneise, "Lectures on the Political Economy of Water Quality Management."

21. Hill, "Our Troubled Waters," p. 3.

22. Council on Environmental Quality, Environmental Quality, p. 123.

23. Hill, "Our Troubled Waters," p. 3.

24. Ibid., p. 3.

25. U.S. Department of the Interior, Hudson River Conference, pp. 341-344.

26. Beale, Pollution Control on the Passaic River, p. 27.

27. Ibid., pp. 29, 50-54.

28. Ibid., pp. 17-18.

29. Combined sewers exist when waste water pipes are connected to stormwater pipes and they form one sewage system. When the system is overloaded by stormwaters, it overflows or bypasses the treatment plant and dumps raw or partially treated wastes into the receiving water.

30. "Primary treatment" removes only gross solids and up to 35 percent of the BOD. "Secondary" is considered minimal treatment and that removes (80 to 90) percent of the BOD. U.S. Environmental Protection Agency, "Needed Clean Air" (Washington, D.C.: Government Printing Office, 1972).

31. Cornelius W. Kruse, "Our Nation's Water: Its Pollution Control and Management," *Advances in Environmental Science*, ed. by Pitts and Metcalf, I (1969), 55.

32 U.S. Department of Commerce, Bureau of the Census, U.S. Census of Housing (1970).

33. Irving Hoch, "Urban Scale and Environmental Quality," *Resources and Environmental Implications of U.S. Population Control*, ed. by Ronald G. Ridker (to be published), p. 39.

34. U.S. Department of the Interior, Federal Water Population Control Administration, and NE Region Hudson-Delaware Basins Office, "An Evaluation of the Significance of Combined Sewer Overflows in the Hudson River Enforcement Conference Area," *Proceedings of the Conference in the Matter of Pollution of the Interstate Waters of the Hudson River and Its Tributaries--New York, New Jersey* (Newark, New Jersey, 1969), p. 68-143.

35. Beale, *Pollution Control on the Passaic River*, pp. 25-26.

36. Jerry J. Cleveland *et al.*, "Evaluation of Dispersed Pollution Loads from Urban Areas," PB-230-746 (Washington, D.C.: National Technical Information Service.

37. The Bay Series (I-IV), *Washington Post*, (July 1971).

38. U.S. Congress, Senate, Public Works Committee, *Water Pollution Control Legislation, Hearings*, Part 3, before a subcommittee of the Public Works Committee, U.S. Senate (Washington, D.C.: Government Printing Office, 1971), p. 1212.

39. U.S. Department of the Interior, Hudson River Conference, p. 369.

40. *Ibid.*, A. W. Bromberg, pp. 53-63.

41. Dr. Stanley Falkow statement in the Enforcement Conference on the Pollution of the Potomac River, I (Washington, D.C. metropolitan area, 1970), 23-26.

42. Public Health Service, *Drinking Water Standards* (1962), p. 2.

43. Bureau of Water Hygiene, *Safe Drinking Water*, pp. 176-177.

44. Public Health Service, *Drinking Water Standards* (1962), p. 2.

45. Public Health Service, *Drinking Water Standards* (1962), p. 649.

46. Public Health Service, *Drinking Water Standards* (1962), p. 180.

47. U.S. Congress, Senate, Committee on Public Works, *Water Pollution Control Legislation, Hearings*, Part 2, before a Subcommittee of the Committee on Public Works, Senate (March 1971), p. 600.

48. Bureau of Water Hygiene, *Safe Drinking Water*, p. 400.

49. Senate, Committee on Public Works, *Water Pollution Control Legislation*, Part 2, p. 600.

50. For a more detailed discussion of the virus problems see Bureau of Water Hygiene, *Safe Drinking Water*, pp. 379-469.

51. U.S. Congress, Senate, Committee on Labor and Public Welfare, "Lead Based Paint Poisoning Amendments of 1972," before a Subcommittee of the Committee on Labor and Public Welfare, Senate (March 1972), p. 67.

52. U.S. Congress, Senate, Committee on Public Works, *Economic Dislocations Resulting from Environmental Controls*, before a subcommittee of the Committee on Public Works, Senate (May 1971), pp. 41-44.

53. Bureau of Water Hygiene, *Safe Drinking Water*, p. 630.

54. Kneise, "Lectures on the Political Economy of Water Quality Management," p. 9.

55. For more discussion of the program refer to: Environmental Protection Agency, Office of Water Pollution, Division of Water Quality Standards, "Questions and Answers on Water Quality Standards," (April 1972).

56. Kneise, "Lectures on the Political Economy," pp. 11-14.

57. Council on Environmental Quality, "Environmental Quality (1972)" pp. 239-240.

58. U.S. Congress, House, Committee on Public Works, report, H.R. 11896, 92nd Congress, 2nd Session (1972), Title III (Section 301).

59. Council on Environmental Quality,"Environmental Quality, (1972)" pp. 239-240.

60. Ibid.

61. Council on Environmental Quality, "Environmental Quality (1972)" p. 273.

SECTION V

SOLID WASTE

V.A Introduction

The most visible of urban environmental problems is solid waste. Streets and alleys are cluttered with garbage, trash, worn out appliances and furniture and frequently, abandoned automobiles. Residents of the inner city often feel that solid waste is the most significant urban environmental problem. Inadequate sanitation and garbage removal were named as significant grievances by the residents of almost half of the cities surveyed by the National Advisory Commission on Civil Disorders. In 1968, solid waste generation in urban areas, exceeded one billion pounds daily.

The problem is growing: incinerators cannot be built because of air pollution requirements; landfills must move further away from cities thus increasing hauling cost; water pollution and dumping requirements are becoming more stringent thus eliminating presently used disposal methods. Most importantly, patterns of consumption are changing. Paper, wood, plastics and glass are all being consumed in ever increasing quantities. An average urban resident generates 5.72 pounds of solid waste per day.[1] By 1980, this figure is expected to rise to almost eight pounds per day.[2]

V.B Inner City Solid Waste

Inner city solid waste problems are more pronounced than those of the urban area as a whole. High population density in conjunction with housing conditions and community economic and educational levels tend to accentuate the problem. Lack of community recreational facilities force children to play in streets, alleys and vacant lots whose proximity to solid waste accumulations cause exposure to rats, vermin and rotting food. Containers are easily knocked over giving rise to broken glass, scavengers and waste strewn all over the area. Abandoned appliances, furniture and automobiles become play toys for children and breeding places for roaches, rats and other pests.

In order to better understand inner city solid waste problems a case study of Wilmington, Delaware will be presented. Wilmington is a typical Northeastern city evidencing most urban problems, but on a smaller, somewhat manageable scale. Poverty, housing abandonment, Model Cities grants and urban renewal are all part of Wilmington's character. Solid waste problems are also a part of that character. In order to discuss the solid waste problem of Wilmington, four subject areas will be considered: solid waste generation and collection, abandoned automobiles, street cleaning and special pickups (used appliances, furniture, etc. too large to be handled during regular service).

V.B.1 Solid Waste Generation and Collection

Wilmington is divided into 36 routes for routine trash collection. All routes are traversed twice weekly, either Monday and Thursday or Tuesday and Friday. Wednesday is left as a bad weather makeup day or for special pick ups. Route size is based upon equivalent numbers of dwelling units in each route. No allowance for density considerations is made.

Data representing 35 weeks of collection during 1971 was collected. (Originally data for the whole year was collected. However, all data sheets containing Wednesday pick ups were disregarded. This was done to eliminate any possible bias that might be caused by water soaked waste.) The unit of measurement was a truck load which represents 20 cubic yards of compacted refuse. All refuse was collected in trucks of this type. Each day, drivers reported the number of loads collected. Number of loads collected weekly ranged from 3.04 to 4.86 with a mean of 3.78 and a variance of .2125.

The Census Bureau poverty map[3] according to the 1969 census was imposed upon a mop of the collection routes in Wilmington. Accordingly, collection routes were classified in one of the following four categories:

I. Contained Entirely within poverty area.
II. Contained Predominately within poverty area.
III. Contained Predominately outside of poverty area.
IV. Contained Entirely outside of poverty area.

Collection routes in their respective categories are shown in Table

The difference between means for Groups I and IV was statistically significant.[4] This implies that refuse generation per poverty area routes was significantly greater than refuse generation per non-poverty area route. Combining Groups II and III and then comparing with IV yielded no significant difference. This implies that refuse generation per routes contained partially in the poverty area did not differ from refuse generation in routes totally outside the poverty area. The comparison of means of II and III versus I yielded significant differences.[5] This infers that generation in totally contained poverty area routes is significantly larger than generation in partially contained poverty area routes.

The inferences that can be drawn from the data serve to reinforce the concepts presented earlier. First, there is a significant difference in the amount of refuse generated between inner city residential refuse routes and other residential routes. Second, since routes are based on approximately equivalent numbers of housing units, the accumulations of refuse at any one time are necessarily larger in the inner city. When this is compounded with the inner city characteristic of high density, probably the cause of the higher generation[6], this accumulation problem becomes acute. In this context, containerization becomes an acute problem.

TABLE 20
WILMINGTON TRASH COLLECTION ROUTES

I[a]		II[b]		III[c]		IV[d]	
Route	Average Loads/Week	Route	Average Loads/Week	Route	Average Loads/Week	Route	Average Loads/Week
B-7	3.53	B-3	4.38	A-6	3.54	A-1	3.95
A-10	3.66	B-6	3.54	A-8	3.48	B-1	3.44
A-12	3.59	A-9	3.65	B-10	4.16	A-2	3.87
B-12	4.16	A-11	3.63			B-2	3.43
A-13	3.56	B-11	3.54			A-3	3.61
B-13	4.06					A-4	3.04
A-14	3.27					B-4	3.09
B-14	4.39					A-5	3.31
A-15	4.56					B-5	3.40
A-16	4.74					A-7	3.51
B-16	4.86					B-8	3.23
A-17	4.29					B-9	4.00
B-17	4.24					B-15	3.89
A-18	3.99					B-18	3.91

[a] Mean = 4.06; variance = .2398

[b] Mean = 3.74; variance was not calculated

[c] Mean = 3.75; variance was not calculated

[d] Mean = 3.54; variance = .1085

Larger accumulations of refuse proximate to more people necessarily implies that containers used in the inner city must be larger, stronger and more accessible to the local residents.

V.B.2 Abandoned Automobiles

In the period July 1, 1970 to June 30, 1971, 958 abandoned automobiles were removed from the streets of Wilmington. Monthly totals ranged from 40 in December 1970 to 147 in July 1970. In a random sample of 100 abandoned cars, 72 were found to have been abandoned within the Census Bureau poverty area. In other words, the probability of having an abandoned auto in the poverty area was 2.67 times as great as having one in another city location.

The city does not incur any direct costs due to the abandoned auto problem. However, substantial indirect costs are involved. First, the police force must ticket all abandoned autos and notify a private towing contractor to have it towed away. Second, abandoned autos serve as a breeding place for rats and other vermin whose control often becomes a municipal responsibility. Third, disposal of the abandoned auto eventually ends up as a city responsibility after all salvage has taken place. Finally, it was estimated by city officials that a three day to two week lead time exists between contractor notification and vehicle removal. During this time traffic is obstructed, children use them for playing areas and the visual aesthetics of a neighborhood are severely impaired. Although not direct or even tangible, these are significant costs to be borne by the city.

V.B.3 Street Cleaning

Depending upon parking regulations, Wilmington utilizes either manual or mechanical means for street cleaning. Manual routes are located predominantly (12 of 16) within the Census Bureau poverty area. In contrast, mechanical routes are predominantly (15 of 19) located outside of the poverty area.

Data was collected for the months of April and May 1972. Frequency of service, total miles traversed, and tons of refuse collected were recorded. The statistic

$$\frac{\text{tons x frequency of service}}{\text{miles}}$$

was calculated for all routes. In both manual and mechanical routes, no significant difference was found between non-poverty area and poverty area routes. The same was true for total tons collected, tons per miles and frequency of service. (Due to the different technologies employed, differences between manual and mechanical were not evaluated.) In other words, the streets are just as dirty in the poverty areas as outside of them.

In our opinion, additional data (this study was based on only two months) would indicate a differential impact on the inner city, i.e. streets located in the poverty area would generate more refuse and require a greater frequency of service.

V.B.4 Special Pickups

Old furniture, broken appliances, or any other refuse too large to be easily handled during scheduled routes is classified as a special pickup. In order to have this refuse removed, a resident must call the Department of Public Works and request removal. Contingent upon their availability, trucks are dispatched to collect the refuse.

A random sample of ten days during May-June 1972, indicated 354 requests for pickup were called in. Of these, 156 or 41 percent originated in the inner city. Lead time between call in and eventual service was estimated to be one week or less.

The existence of special pick up items on inner city streets and alleys precipitates many of the same problems associated with abandoned automobiles. They serve as breeding places for rats and vermin. They become play toys for neighborhood children who lack recreational facilities. Scavengers dismantle and remove the salvagable components leaving the valueless shell strewn over the street. Finally, aesthetics of the neighborhood are severely impaired, inflicting possible psychological harm upon the residents.

V.B.5 The Inner City Solid Waste Problem

To understand why the inner city has acute solid waste problems, one must delve into its character. Deteriorating physical plant combined with high density conditions are the basic problems. The generally lower socio-economic status of the residents serve to magnify the problem. Streets crowded with automobiles not only produce significant air pollution but also seriously hamper the movement of collection vehicles. Rampant crime imparts fear to residents and inhibits neighborhood cooperation in the solution of neighborhood problems.

Numerous frustrations with urban life manifest themselves in solid waste problems. The existence of vast amounts of substandard housing provide little incentive to keep streets, alleys and back yards free from debris. Lack of education and opportunity serve to further destroy these incentives.

Conditions dictated by economics magnify the problems. Eating habits based on below poverty level incomes create food wastes, as residents are forced to purchase cheaper, lower quality food stuffs. Dilapidated furniture and worn out appliances become more prevalent as residents cannot afford to maintain the old or purchase new household wares.

Decreasing city tax bases and increasing demand for city services, especially among poverty communities, can result in cut backs in collection frequency or street cleaning. Refuse that was collected bi-weekly may now only be collected weekly. Accumulations become more severe. The ultimate result is more refuse in streets and alleys proximate to residents who have neither the means nor the incentive to deal with the problem.

Inner city solid waste problems form a vicious cycle. The presence of solid waste in the streets, alleys and hallways precipitates more litter, more collection problems. As collection lags behind generation, the problem magnifies.

Solutions to inner city solid waste problems must impinge directly on these sources. Collection must be made more efficient, more frequent. (Some areas of New York City have collections daily while others only have it weekly.) Systems that provide incentives to both manufacturers and consumers must be developed. Better housing, higher standards of living and education must also be made part of that system.

In summary, the following conclusions about inner city solid waste problems may be drawn:

- Solid waste generation in the inner city tends to be larger per route of approximately equivalent housing units than generation in other parts of the city.
- Due to increased density, lack of recreational facilities and the increased generation rate, accumulation and containerization problems in the inner city are especially acute.
- The frequency of abandoned cars in the inner city is much larger than in other areas of the city.
- Generation of special pickup refuse is disproportionately higher in poverty areas than throughout the remainder of the city.
- Processing and disposal of inner city solid waste constitutes a significant city government problem.

V.C Health Hazards

Quantitative understanding of solid waste/disease relationships is non-existent. Therefore, a discussion on health effects must be very general and qualitative in nature. The health effects of solid waste in the inner city can be divided in two general categories: direct and indirect.

Direct health effects can be illustrated by the presence of rats and other vermin in the inner city. It is estimated that between 60 and 90 percent of all rat bites occur in the inner city.[7] Solid waste accumulations serve as breeding places for disease carriers such as rats, flies, mosquitos, and others. The presence of these household pests precipitates the use of pesticides in order to control them.

The disposal of solid waste pollutes the air and water. Incineration releases noxious gases and particulates in the air. Waste dumped into waterways destroys plant and animal life. Sanitary land fills and open dumps can result in methane generation and contamination of ground and surface waters.

Solid waste accumulations are also fire hazards. The Director of Environmental Services of the District of Columbia, James P. Alexander, testified before Congress that Operation Clean Sweep resulted in fewer fires.

Finally, the psychological impact of inner city solid waste is substantial. The presence of poor housing and the accumulation of solid waste are obviously interrelated. Frustration over environmental conditions can lead to crime, and withdrawal from community efforts to improve the neighborhood environment. This can result in further deterioration and abandonment.

V.D The Impact of Solid Waste Legislation

Solid waste legislation has been primarily directed toward the development of solid waste management techniques and providing technical and financial assistance to solid waste management agencies. The major impact in the inner city has been in the funding of demonstration grants and providing technical assistance.

In reality, there are no solid waste standards. EPA programs are geared to having local government improve their solid waste management. New collection vehicles and systems, programs in containerization and training programs have constituted the major thrust of EPA action.

Federal programs in the inner city have made some short term impact upon the solid waste problem. Using EPA technical assistance, the city of Cleveland, Ohio was able to save $3 million by improving the efficiency of the waste collection system. Certain containerization demonstration grants have had considerable success. Plastic bags have been adopted by some communities in an effort to attack the containerization problem. Community action programs, such as the District of Columbia's Operation Clean Sweep have also been moderately successful in providing some short term solutions.

Other Federal action in solid waste has been to stimulate recycling through tax exempt bonds. This permits private industry to finance recycling facilities with tax exempt industrial development bonds. The intended outcome of this program is to make recycling an economically competitive method for municipal solid waste disposal. This program would have direct benefits to center city environments by easing the disposal problem now confronting many areas.

Contemplated EPA actions in the areas of inner city solid waste include

1. Upgrading urban waste disposal services generally.

2. Improved handling and storage of wastes in existing housing.

3. Developing improved waste handling and storage methods in public housing.

4. Encouraging inner city businessmen to participate in refuse handling enterprise.

5. Supporting inner city cleanup campaigns.

In summary, proposed EPA action will do much to attack the inner city solid waste problem. The eventual cure, however, will require some additional programs. It is not enough to remove the waste generated. Rather, the character of the waste must change. Recycling must be economically encouraged. Biodegradable products need to be developed. Consumption patterns must be altered. Above all, the conditions aggravating the solid waste problem must be removed. This implies better education and economic opportunities for center city residents and removal of poverty as an urban characteristic.

FOOTNOTES

1. American Chemical Society, Cleaning our Environment (Washington, D.C.: American Chemical Society, 1969), p. 165.

2. Richard D. Vaughn, "National Solid Waste Survey and Interpretation," National Survey of Community Solid Waste Practices (1968), p. 47.

3. Census Bureau poverty areas are determined by an index of five equally weighted poverty-linked characteristics:

    1. Percent of families with cash incomes below $3000 for previous year.
    2. Percent of children under 18 years old not living with both parents.
    3. Percent of males 25 years old and over with less than 8 years of school completed.
    4. Percent of unskilled males (laborers and service workers) aged 14 or over in the employed civilian labor force.
    5. Percent of all housing units dilapidated or lacking some or all plumbing facilities.

    After the index was developed for each tract, the lowest economic quartile were designated as poverty areas. Therefore, 41 percent of the special pickups generated were generated by the lowest economic quartile of the population. (Source: Maps of Major Concentrations of Poverty in SMSAs of 250,000 or More Population, O.E.O. 1966).

4. $p<.005, t = 3.30$, 26 df.

5. $p<.01, t = 1.367$, 20 df.

6. U. S. Environmental Protection Agency, Residential Solid Waste Generated in Low Income Areas, by George R. Davidson, Jr., (Washington, D.C.: Government Printing Office, 1972).

7. Council on Environmental Quality, Environmental Quality (Washington, D.C.: Government Printing Office, 1971), p. 197.

SECTION VI

NOISE

VI.A Introduction

In a sense, the magnitude of the noise problem is proportional to the number of people whose lives are significantly degraded by noise.[1] Noise is defined as unwanted sound. Essentially, sound can be described as vibration in an elastic medium. In analyzing center city-surburban noise differentials, population characteristics such as age play a crucial role. With age there is a reduction in the decibel range which can be heard. Both physiological and psychological factors determine whether the noise is "unwanted sound." It is necessary to consider individual perception in analyzing sounds.

Often when measurements of noise are taken, citizen perception is analyzed from surveys in different locales. Results are then compared to actual measurements which are monitored in the area. This gives an important comparison of annoyance and the actual intensity of the noise present in an environment.

VI.B Noise Measurement

There are various manners in which to measure noise. Sound level, sound pressure level, sound power, sound intensity, phons and sones are some of the terms relating to noise levels. Noise can be measured in the total amount of acoustical energy radiating into the air per unit of time from a source. This is sound power, but the common expression for magnitude or level of noise is the decibel. Based on a standard reference value computed using atmospheric pressure, the decibel, dB, is a measure on a logrithmic scale of the magnitude of a particular quantity of noise.[2]

The limits of the human listener in acoustic energy is between 2-20,000 hertz (Hz.)[3]. However, the human ear does not respond directly to energy, but rather to the sound pressure.[4] When sound enters the external ear the aural reflex is set into motion by the tympani and stapedius, two small muscles in the middle ear. The eardrum and the three bones of the middle ear transmit vibrations to the fluid filled inner ear. Vibration of fluid sets up a complex of waves in the cochlea which exerts pressure on the hair cells of the organ of corti. The auditory portion of the cranial nerve terminates at the hair cells. Fluid vibrations are coded into impulses which the brain interprets. Using the smallest sound pressure that normal ears can hear, 0.00002 microbars, decibel levels were developed with this level being the reference level of 1.0 decibel. Because the ear does not respond to all frequencies equally, scales were devised to relate to the different sensitivity levels. To obtain a basis to measure the middle frequencies which the human ear best responds to, a weighted scale was developed reducing the effects of low and high frequencies. The sound level is said to be A-weighted. Thus, most common measurements of noise are done in units of

A-weighted decibels (dBA) when concerned with the effects on people.

VI.B.1 Ambient Noise

Residual or ambient noise is the fairly constant lower noise level in an environment. Studies done by the Environmental Protection Agency for the Report to Congress on Noise displayed a varying degree of ambient noise in environments such as rural farms, small town residentials, suburban residential, and urban residential.[5] These outdoor noise levels were collected and mean dBA levels computed for city, suburban and detached housing. Results point to a higher median noise level (73.0 dBA daytime, 65.5 dBA nighttime) in the city than in the suburban or detached housing (50.9 dBA daytime, 44.2 dBA nighttime).[6] Irving Hoch pointed out in Urban Scale and Environmental Quality that outdoor noise levels in the central section of large cities are on the order of twice the perceived level in the residential areas of suburbia or small towns.[7] This doubling of perceived level indicates a ten decibel increase. Residual noise levels in suburban and rural areas seldom interfere with normal speech communication. However, in urban communities, especially the very noisy downtown urban residential areas, speech interference is frequent. In the study "Transportation Noise and Noise from Equipment Powered by the Internal Combustion Engine" by Wyle Laboratories, types of communities were listed with corresponding 16-35 dBA for wilderness and rural to 56-75 dBA for very noisy central city areas during daytime hours. Similarly, a Bolt, Beranek and Newman study, reported even higher daytime noise levels (see Figure 1) in various cities, particularly in areas with heavy bus and truck traffic.[8]

Ambient noise levels in the center city are higher than average residential levels. The residents of center cities are exposed to 30 to 40 decibels greater than residents of suburban or rural areas. The primary reason for the greater intensity is the concentration and combination of noise sources present in the urban center which are not present in suburbia. A study done in Inglewood, California presented to the Subcommittee on Air and Water Pollution in 1972 displayed the levels of ambient noise for different environmental areas.

Central city residents are exposed to noise levels which combine residential, commercial and industrial noises. Other sources of noise adding to the noise levels of the central city are construction activity and traffic. Intensity and types of construction (e.g., industrial and commercial rather than residential) are influencing factors on the noise level. Intensity of traffic in the urban areas, including type of vehicles--trucks, cars, motorcycles, etc.--and quantity per unit of time, also compounds the noise level. Studies done in Canada by Thiessen and Olsen of the National Research Council in Ottawa indicate that ambient noise in the urban environment is distinctly higher than rural areas with a primary factor being motor vehicle noise.

It has been established that the center city environment is definitely noisier than less densely populated areas of suburbia. There are many compounding factors to noise pollution in the center city. Review of the general pollution sources causing greatest noise levels in the center city displays the complexity of monitoring specific noises. For this analysis, noise sources in the center city are classed as industrial, commercial, municipal, mobile and domestic. These are summarized in Table 21.

VI.B.2 Industrial Noise

Usually, industrial and commercial operations are located in heavily populated urban areas due to the large proportion of skilled and semiskilled workers.[9] The residual noise in the community surrounding the industrial site is generally raised by groups of plants and businesses. In 1967 the Department of Commerce Statistical Abstracts reported that there were 311,000 industrial establishments in the United States. A large proportion of these are in urban areas where they can add to the residual noise environment of the city. In the 1972 Report to Congress on Noise, industrial activities as potential noise producing sources, are grouped into four basic types: product fabrication, including metal fabrication and molding, product assembly, power generation and process plants. Noise levels of a glass manufacturing plant, a power plant and an automobile assembly plant located proximate to the center city were monitored. One interesting feature of the report is a comparison of residual noise levels at various community sites with residual noise levels at the plant property lines. A glass manufacturing plant produced a residual noise level of 68 dBA, which was 9-24 decibels higher than the community residual noise levels in proximity to this location. The major noise source was high pressure air used for cooling and operation of the glass molding machines. In a second example, residual noise level at the power plant property line was 80 dBA at the peak weekday measurement, which is 29-31 decibels higher than community residual noise nearest this site. A major source of noise at the power plant is the steam turbogenerator or gas turbine generator.

Another example of increased residual noise is the automobile assembly plant. The highest residual noise level at the plant property line was 62 dBA, which range from 12 to 14 decibels louder than the residual levels in the neighboring community nearest the location. In sum, it seems likely that the higher residual noise levels will have detrimental effects on the surrounding area and the residents living there.

Generally, there are five major categories of industrial plant noise sources.[10] At the operators position associated with these processes the noise levels produced range from 80 dBA (blowers) to 122 dBA (pneumatic chippers).[11] Other specific noise levels emitted from industrial equipment are

TABLE 21
SOURCES OF DIFFERENTIAL POLLUTION

Source	Noise Levels (Maximum)
Industrial Equipment*	
Blowers	80 dBA
Pneumatic Chippers	122 dBA
Oxygen Torch	126 dBA
Textile Loom	122 dBA
Bench Lathe	95 dBA
Milling Machine	90 dBA
Municipal or Commercial Construction**	
Compacters	75 dBA
Front Loaders	85 dBA
Backhoes	93 dBA
Tractors	95 dBA
Scrapers, graders	93 dBA
Pavers	88 dBA
Generators	82 dBA
Pneumatic Wrenches	89 dBA
Trucks	93 dBA
Concrete mixers	88 dBA
Cranes	88 dBA
Jack hammers, rock drills	98 dBA
Impact Pile Drivers	106 dBA
Pavement Breakers	115 dBA

* Source: U.S. Environmental Protection Agency, Improving the Inner City Environment, by Task Force on Environmental Problems of the Inner-City (1971).

** Source: U.S. Environmental Protection Agency to Congress and the President on Noise.

TABLE 21 (Continued)
SOURCES OF DIFFERENTIAL POLLUTION

Source	Noise Levels (Maximum)
Mobile Sources**	
Sports Car	90 dBA
Standard Car	73-80 dBA
Medium Trucks	88 dBA
Motorcycles	88-95 dBA
Utility, maintenance Vehicles	88 dBA
Highway buses	86 dBA
City and School Buses	85 dBA
Light Trucks	86 dBA
Freight, Passenger Trains	94 dBA
Rapid Transit	86 dBA
Trolley Cars	68-80 dBA
Subway Trains	100 dBA
Domestic Sources**	
Alarm clock	85 dBA
Clothes Washer	82 dBA
Vacuum	72 dBA
Toilet Flush	65 dBA
Food Blender	100 dBA
Lawn Mower	90 dBA

** Source: U.S. Environmental Protection Agency to Congress and the President on Noise.

the oxygen torch (126 dBA), textile loom (122 dBA), bench lathe (95 dBA) and milling machine (90 dBA).[12] Each of these sources emits high intensity noise and would raise the residual noise level in the plant itself and the neighboring area if the facilities were not sound tight.

VI.B.3 Commercial Noise

Many commercial operations include equipment similar to that used in industrial operations. A newspaper press, for example, produces 101 decibels and a key punch machine 82 decibels. Commercial businesses which require constant loading and unloading of vehicles contribute to the residual noise level in the central city. Additionally, nightclubs or other entertainment spots produce high levels of noise: discotheques have been known to produce noise levels of 120 decibels. Noise levels in shopping areas, restaurants, even the stock exchange, are increased considerably when they are filled with people. Normal conversation produces 60 dBA, but with increased density this volume would be raised.

It has also been pointed out earlier in the report that construction in the inner city is noisier than in suburban construction. A major component of construction noise is associated with exhaust and engine casing of engine powered equipment. Construction equipment constantly vary in terms of load and rpm during normal operation, which adds to the peaks in residual noise.[13] Some of the peak noise emissions from specific types of heavy construction equipment are: compacters (75 dBA), front loaders (85 dBA), backhoes (93 dBA), tractors (95 dBA), scrapers and graders (93 dBA), pavers (88 dBA), trucks (93 dBA), concrete mixers (88 dBA), cranes (88 dBA), generators (82 dBA), pneumatic wrenches (89 dBA), jack hammers and rock drills (98 dBA), impact pile drivers (106 dBA) and pavement breakers (115 dBA).[14]

It can be seen that with a combination of sources concentrated at several sites the noise level is quite intense. During construction of roads and highways, for example, levels of 84-88 decibels are not uncommon. Public works construction raises the noise level considerably for the surrounding area.

Other sources of municipal noise are sirens from police or fire emergency equipment, which reach noise levels of 95 dBA. Street cleaning operations, (i.e., street sweepers) produce noise to 87 dBA. Garbage collection noise levels sometimes reach 83 dBA and are often a frequent subject of complaint from residents in the center city.[15]

VI.B.4 Mobile Noise

Rail vehicles and aircraft constitute another source of noise pollution in the center city. Noise levels associated with the former are presented in the publication "Transportation Noise and Noise from Equipment Powered by the Internal Combustion Engine".[16] Included are freight and passenger trains (94 dB), rapid transit (86 dB), trolley cars (new, 68 dB-old, 80 dB) and subway trains (100 dB). The impact of these mobile sources on the noise level in the center city varies from region to region. For example, subway noise is common in some of the larger cities such as New York. In contrast, center city residents in Baltimore have to contend with the din emanating from trains. Similarly, San Francisco's trolley cars assault the ears, but most residents enjoy the nostalgia associated with transportation from a bygone era.

Generally, aircraft flight patterns run over the center city area. The Subcommittee Hearings on Noise in 1972 displayed aerial maps of California flight patterns in relation to the center city. Approach noise levels at 1000 feet range from 82 dB for propeller aircraft to 100 dB for four engine turbofan and take-off noise levels from 90 dB to 105 dB, respectively. Long and medium range aircraft, including Boeing 747, 707 and 727 have approach levels ranging from 90-100 dB and takeoff levels from 100-105 dB.[17] Jet aircraft noise at 200 feet can reach levels of 150 decibels. Therefore, those areas closest to approach and takeoff are subjected to highest intensities of aircraft noise. One specific example is Inglewood, California whose residents have been adversely affected by noise levels from L. A. International Airport.

Frequent complaints from suburban areas involve aircraft noise; however, these complaints may be the result of lower residual noise levels in suburban areas compared to those in the inner city. Most airports are located close to urban centers, and the people here are subjected to that portion of the flight producing the greatest amount of noise.

VI.B.5 Domestic Noise

The last category of noise sources, domestic, includes products used by the person in his home environment. Some of the items which would generally be present in the center city home are: alarm clock (85 dB), clothes washer (82 dB), vacuum (72 dB), toilet flush (65 dB), perhaps food blender (100 dB) and lawn mower (90 dB, at operators position).

Two points are worth noting. First, although domestic sources are minor in comparison to other noise sources, home appliances do contribute to the overall noise level. Second, the fact that some of the items are more prevalent in suburban homes (e.g., lawn mowers) does not mean that center city residents necessarily benefit from their absence. For example, lack of air conditioning in most center city homes makes it necessary to leave doors and windows open. Thus, many outside noises cannot be shut out during hot weather months. Furthermore, electrical appliances found in center city homes are frequently older and usually of inferior quality compared to those in more affluent suburban homes. The center city resident may have to buy cheaper models, or keep older appliances which probably do not have quieting devices.

With consideration given to the environment of the center city, it seems likely that these residents are exposed to greater noise levels. It has been shown that the center city has commercial, urban industrial, urban traffic and residential noises which contribute to a high ambient noise level. Residents are exposed to high intensity noises at home, as well as at work. Census Bureau statistics of occupational information for metropolitan-nonmetropolitan residences show more center city residents work in services and operatives where noise levels are higher than clerical, professional, or other quieter occupations. Therefore, working center city residents are often exposed to longer hours of high noise levels and must return home to environments louder than suburban areas.

In addition to the array of noise sources already described, the tall, flat surface buildings in the inner city cause energy reflection. The sound energy can be propagated as long as sufficient energy exists to keep the particles in motion.[18] Shrubbery and trees would lessen this reflecting action. Unfortunately, there is little greenery in the center city.

VI.C Health Hazards

Although the higher noise levels present in the center city imply detrimental health effects, documentation is rare. Hence, the present discussion must rely on indirect evidence of physiological and psychological damage resulting from differential exposure to extreme noise levels. Sounds most people are subjected to in the central city include noises exceeding the danger level of 80 dBA. (For example, heavy traffic (90 dBA), subways (100 dBA) and heavy duty power equipment (110 dBA).

The natural decline in audibility with age is called presbycusis. According to Kryter, the amount of presbycusis may be directly related to exposure to noise in everyday living.[19] The term "sociocusis" is used sometimes to show the relation between environmental noise and hearing damage. The noises most dangerous to hearing are those which continue over time, e.g., sirens and jet engines.[20] Discomfort is the first sign of noise deafness. If the sound is loud enough, pain will occur. This may be accompanied by an uncomfortable ringing known as tinnitus.

There are other effects of noise on human health. Noise directly alters the rhythm of the heartbeat, increases the level of cholesterol in the blood and raises blood pressure.[21] Moderate noises can cause small blood vessels to constrict and impede blood flow. The blood vessels in the brain dilate with noise exposure, which may result in headaches. In his paper, "The Effects of Noise on Health," Jansen points out that blood circulation does not adapt to continuing noise exposure. Vasoconstriction was first observed at 60-70 dBA and as sound intensity increased the condition became more pronounced. Similarly, Alice Suter of the National Association of Hearing and Speech Agencies suggests that the process of vascular constriction does not adapt and limits the supply of blood to the ear.[22] Lack of proper blood supply to the ear over time would contribute to old age hearing loss. Workers exposed to high noise levels have a higher incidence of cardiovascular disease, ear, nose, and throat disorders than workers in less noisy surroundings. Other stressful effects of noise are changes in secretion of endocrine hormones and kidney functions. Continued stress may increase susceptibility to infection, gastrointestinal ulcers or high blood pressure.

The more subtle affects of noise are psychological. People working in noisy surroundings tend to be more agressive and distrustful. A noisy home environment may cause fatigue, irritability and, in extreme cases, can lead to hallucinations and suicidal and homocidal tendencies if sleep is disrupted over long periods.[23] Curiously, suddenly removing loud noises from the environment could also affect an individual's psychological state. The city dweller, coming in contact with high outdoor and indoor noises, becomes accustomed to the sounds. In a Report to Congress in 1937, it was pointed out that, in characteristically noisy places, sudden silences frequently prove to be oppressive for those accustomed to varying sounds.[24]

VI.D The Impact of Noise Legislation

The Clean Air Amendments of 1970 established the Office of Noise Abatement in the Environmental Protection Agency. With the development of this office, investigation, planning and legislation of noise levels is now underway. Present authority for EPA is limited. However, the National Environmental Policy Act of 1969 may have considerable effect on projects where noise is a consideration. The Act requires agencies of the Federal government to consider environmental impact in deciding on project development.[25]

The proposed Noise Control Act would allow EPA to set standards limiting the noise-generation characteristics of construction and transportation equipment and other equipment powered by the internal combustion engines.[26] The Third Annual Report of the Council on Environmental Quality describes the proposed authority for the Administrator of EPA to require labeling of household products and appliances.[27] "The pending Noise Control Act of 1972, passed by the U.S. House of Representatives in February 1972, would bar State and local governments from applying any but Federal noise standards to products covered by Federal law."[28] The Act would provide authorization for EPA to assist State and local governments in matters concerned with noise control. Additionally, the bill (S. 1016) gives EPA authority to set aircraft noise standards. This power currently is held by the Federal Aviation Administration.

It should be emphasized that coordination and cooperation among Federal, state and local authorities is essential for proper noise control. Though specific powers have not yet been granted to the Environmental Protection Agency to construct noise standards and regulations, there are other Federal agencies which have policies dealing with noise.

Under the Department of Transportation the Federal Highways Act and the Airport and Airway Development Act now give consideration to noise levels. Because of their interstate nature it would seem natural for Federal regulation to include truck and commercial vehicle noise. The amended Federal Aviation Act of 1958 gives the Administrator of the FAA power to fix standards for the measurement of aircraft noise and regulations for noise control and abatement.[29] Public Law 90-411 specifically requires the FAA to establish and enforce regulations to control aircraft noise.[30] Noise standards and maximum noise levels for certification of all new subsonic transport airplanes is established under this law. Maximum levels are 93 and 108 EPNdB[31] depending on type and size of aircraft.[32]

The Department of Housing and Urban Development also has noise control legislation. "It is HUD's general policy to foster the creation of controls and standards for community noise abatement and control by general purpose agencies of State and local governments, and to support these activities by minimum national standards by which to protect citizens against the encroachment of noise into their communities and places of residence."[33] Noise is divided into three groupings, which can be defined as standards: (1) acceptable, (2) discretionary--normally acceptable or normally unacceptable, (3) unacceptable.[34] Presently, noise exposure for sleeping quarters is considered acceptable if interior noise levels resulting from exterior noise sources and interior building sources "do not exceed 55 dBA for more than an accumulation of 60 minutes in any 24-hour period; and do not exceed 45 dBA for more than 30 minutes during night time sleeping hours from 11 p.m. to 7 a.m.; and do not exceed 45 dBA for more than an accumulation of eight hours in any 24-hour day."[35] The Housing Act of 1964 and National Housing Act give HUD authority for loan insurance for rehabilitation and major home or property improvements.[36] Residents of new homes built with HUD aid are protected against extreme noise exposure.

Another Federal plan to control noise is the responsibility of the General Services Administration (GSA). Maximum allowable noise levels for selected construction equipment used on Federal projects have been set.[37] Bids taken after June 30, 1972 will include noise levels for specific equipment, thus, encouraging the development of quieter machinery.

The Department of Health, Education and Welfare also acts in Federal noise control. The Occupational Safety and Health Act limits noise exposure for workers. This act protects workers by limiting exposure of 90 dBA to eight hours, and any noise of 115 decibels to 15 minutes.[38] Noise levels are also restricted in hospitals and other health facilities under HEW's control.

The proposed legislation for EPA in combination with existing noise controls will affect emission sources. The penalty for violation of the regulations proposed in the bill before the Congress is a fine of not more than $25,000 for each violation. The Environmental Protection Agency has power to assess a civil penalty for a violation with the district courts of the United States having jurisdiction of actions brought by the government.

In order to examine the probable impact of current and proposed legislation designed to combat noise pollution, the emission sources previously described can be classified as internal and external. The former are noise sources indigenous to the center city (i.e., residential, municipal, and commercial); the latter are outside sources over which center city inhabitants have little or no control (i.e., industrial and mobile).

The HUD, HEW and proposed EPA regulations are designed to protect the urban resident from extreme noise levels. There would be limits on the noise emissions from manufactured products. Codes for building or rehabilitating would limit noise levels in the home. The HUD standards previously mentioned are primarily concerned with sleeping quarters and may only affect those residents moving to new homes or renovated buildings. The Federal legislation would only adversely affect the residents of the center city by price increases on products with new quieting devices.

Earlier in the report it was stated that a great deal of construction in the inner city is controlled by the municipality. The HUD noise regulations would have to be maintained in the projects if funding assistance were needed. This would dictate installation of proper sound proofing to fulfill the requirements for the 'acceptable' standard under HUD's regulations. Construction equipment would have to be classified according to decibel emissions to coincide with GSA policies. Under the Occupational Health and Safety Act, municipal employees are protected from extreme noise levels. Decibel levels have to be held at or below the 90 decibel level for a working day. Protective devices must be supplied if noise levels are greater than the safety regulations. Municipal authorities act in planning and land use allocation and would be subject to FAA discretion if new airports were proposed. The FAA has the power to dictate where facilities will be built.

The basic same regulations also affect the commercial businesses in the center city. Restrictions on transport vehicles, trucks, vans, etc., included in the Federal Highways Act or the proposed EPA standards would affect noise emissions from these vehicles. Commercial construction would be restricted in the same manner as municipal work.

Some "internal" emission sources also qualify as external sources of noise, i.e. those which bring pollution into the city. For example, residents do not have control of the immigration of mobile vehicles into the center city. Industries are not necessary for the make-up of a center city, though often they will be present in urban areas. Generally speaking, the Federal noise regulations which would affect industry are HEW occupational standards for employees, construction limits found with GSA regulations and the proposed legislation on manufactured products which will be handled by EPA. The Department of Transportation has regulatory powers over automobiles, some rapid transit, aircraft and other transportation vehicles. Aircraft noise would be controlled or limited by the FAA.

Generally, the Federal legislation seems to have little power over the noise sources which are present in the center city. Greater control is exercised by local or State governments. Local governments deal with specific locales and the problems characteristic to the area. Perhaps Federal legislation or standards would help bring uniform environmental conditions. It must be emphasized that investigation into possible outcomes of uniform Federal control is necessary. It may be found that Federal legislation could actually take away basic rights of the individual citizen.

FOOTNOTES

1. The diffusion model is a mathematical analysis of pollutant emissions, metrological conditions, and typographical features. The purpose is to provide approximate spatial distributions of long term and seasonal average pollutant concentrations. Topography is also reflected in the model when it affects meterological conditions. Meterological factors include wind, speed, direction, and mixing heights. Health, Education, and Welfare; Public Health Service; National Air Pollution Control Administration; Division of Air Quality and Emissions Data (Durham, North Carolina), pp. 1-36.

2. U.S. Environmental Protection Agency Administrator speaking to U.S. Congress and the President on Noise, February, 1972, Doc. No. 92-63, p. 221.

3. A hertz is equal to a cycle per second.

4. Environmental Protection Agency to U. S. Congress and the President on Noise.

5. Environmental Protection Agency to U.S. Congress and President on Noise, pp. 360.

6. Ibid., pp. 2-15.

7. Irving Hoch, "Urban Scale and Environmental Quality," Resources and Environmental Implications of U.S. Population Control, ed. by Ronald G. Ridker (to be published), p. 39.

8. Blazier et al., Chicago Urban Noise Survey, Part 1, "Noise in the Urban Environment" (Chicago: Bolt, Beranek, and Newman, Inc., 1970).

9. James Q. Wilson, Metropolitan Enigma (Harvard University Press, 1968).

10. Five major categories of industrial plant sources: impact, including punch, presses, stamping, hammers; mechanical, which involves machinery unbalance, gears, bearings; fluid flows concerned with fans, blowers, compressors, valves; combustion, including furnaces and flare sticks; and electromechanical devices such as motors, generators, transformers. Report to the President and U.S. Congress on Noise, pp. 2-89.

11. U.S. Environmental Protection Agency, "Improving the Inner-City Environment," 1971.

12. Ibid.

13. Dietrich, Franken, Jones, Analysis of Community Noise and A Plan for Noise Control for the City of Boston Air Pollution Control Commission, Report 2069 (March, 1971).

14. U.S. Environmental Protection Agency report to President and U.S. Congress on Noise.

15. Environmental Protection Agency, *Community Noise*, by Wyle Laboratories (1971).

16. Environmental Protection Agency, *Transportation Noise and Noise from Equipment Powered by Internal Combustion Engines*, by Wyle Laboratories (1971).

17. U.S. Environmental Protection Agency, *Improving the Inner City Environment*, by Task Force on Environmental Problems of the Inner-City (1971).

18. Environmental Protection Agency, Report to the President and U.S. Congress on Noise.

19. Earl Kryter, *The Effects of Noise on Man* (New York: Academic Press, 1970).

20. Theodore Berland, *Smithsonian Magazine*, July, 1972, pp. 15-21.

21. *Ibid*., p. 17.

22. U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *The Social Impact of Noise* (Washington, D.C.: Government Printing Office, 1971).

23. Berland, *Smithsonian Magazine*.

24. Environmental Protection Agency, *The Social Impact of Noise*.

25. James L. Hildenbrand, "Noise Pollution: An Introduction to the Problem and an Outline for Future Legal Research," *Columbia Law Review*, April, 1970, pp. 652-692.

26. Council on Environmental Quality, *The Third Annual Report* (Washington, D.C.: Government Printing Office, 1972).

27. *Ibid*., p. 132.

28. *Ibid*., p. 210.

29. *Ibid*., p. 681.

30. U.S. Department of Housing and Urban Development and U.S. Department of Transportation. *Metropolitan Aircraft Noise Abatement Policy Study* by Northeastern Illinois Planning Commission (Washington, D.C.: Government Printing Office, 1971).

31. EPNdB--effective perceived noise level. This includes "the effects of strong tones and long duration of noise exposure in order to evaluate the qualities of aircraft noise that are particularly offensive to persons on the ground." (Congressional Record - Extensions of Remarks, October 29, 1969, Compilation of State and Local Ordinances on Noise Control.)

32. Northeastern Illinois Planning Commission, Metropolitan Aircraft Noise Abatement Policy Study, p. 104.

33. U.S. Department of Housing and Urban Development, "Transmittal Noise," #1390.2 (Washington, D.C.: Government Printing Office), p. 1.

34. Ibid., p. 3.

35. Ibid., p. 9.

36. Department of Housing and Urban Development and Department of Transportation, Metropolitan Aircraft Noise Abatement Policy Study.

37. Council on Environmental Quality, Third Annual Report.

38. Federal Register of Rules and Regulations, "Noise Limits Under Occupational Safety and Health Act of 1970," XXXIX, No. 105 (Washington, D.C.: Government Printing Office, 1971).

SECTION VII

RADIATION AND CLIMATIC CHANGES

VII.A Radiation

For the general population the most significant amounts of radiation exposure are due to natural background sources and medical applications.[1] The background consists of cosmic radiation and radioactivity naturally existing in the elements of the soil, water and air as well as within our bodies. The estimated dose from this source is from 100 to 125 millirems (mrem) per year.[2] The medical uses of x-rays, fluoroscopy and radioisotopes account for the exposure to patients of an estimated average annual genetically significant dose of .60 to 95 millirems.[3]

Although nuclear power plants have increased over the last decade in terms of electrical energy output, their contribution to environmental radiation remains relatively small. A 1969 study of thirteen operating power plants concluded that the annual dose to the total population living within fifty miles of these sites averages about 0.01 mrem.[4] This is well below 1% of both the radiation protection guidelines and typical natural background exposure. The problem of radioactivity from the testing of nuclear devices has decreased severalfold over the past few years as a result of the moratorium on atmospheric testing. Measurements of fallout debris exhibit a marked decline after peaking in the early 1960's. The U.S.-U.S.S.R. atmospheric testing agreement was ratified in August 1963 by the U.S.[5]

The current Federal regulations call for a maximum of 500 mrem per year (for whole body exposure) from all man made sources excluding medical sources for individual members of the general public, and 170 millirems per capita per year for population groups.[6] The measurements for the general population show that the exposure is below the maximum Federal limit. No increased exposure for center city populations is found from gross radioactivity.

VII.B Nonionizing Radiation - Electromagnetic Waves

During the last twenty-five years, electromagnetic radiation in the environment has increased by several orders of magnitude. This is radiated in the microwave and radiofrequency (rf) regions of the nonionizing electromagnetic spectrum. The sources of this include AM, FM and TV broadcasting, microwave ovens, and radar devices. Electromagnetic radiation is propagated in the form of waves which can be measured in several ways. Frequency is measured in hertz (Hz), wavelength in meters, energy in joules or electron volts, power in watts and densities in watts per square meter (or milliwatt per square centimeter). Exposure dose to this type of radiation is measured in terms of exposure power density and the duration of exposure (such as milliwatt per square centimeter for one hour). The American National Standards

Institute has recommended that occupational exposure for frequencies between 10MHz and 10GHz (that is 10^6 to 10^9 hertz) not exceed 10mw/cm^2 for periods of .1 hour or longer.

Studies are now being done by the Office of Radiological programs and the Office of Research and Monitoring of EPA to determine two things: (1) the environmental levels that this radiation has reached in cities, and (2) the biological effects of exposure to this radiation.

An example of the first type of investigation is a study of eight large metropolitan areas of the United States. The total number of AM, FM and TV stations was taken and the total power in megawatts was derived from the output of each station. The results are presented in Figure 1 along with the population of each area. San Francisco stands out by its 13 megawatts (13,000,000 watts) of effective radiated power in a city of only 4 million people and less than 40 broadcast stations. Philadelphia and Chicago are found to have the next highest amounts of power, about 9.0 and 7.5 megawatts respectively. Determinations such as this one may be useful in identifying populations that receive the greatest exposure. In general, there is greater exposure where there are concentrations of people in urban areas.

In order to determine the typical levels of rf and microwave radiation that result from manmade sources in an urban environment, measurements were made of peak power densities in the Washington, D.C. area during the summer of 1969. Table 7.1 shows the highest levels measured (approximately 0.008 mw/cm^2) which originated primarily from broadcast towers and airport installations.[7] Figure 2 shows a map with the location of the monitoring sites.

TABLE 22

MAXIMUM OBSERVED POWER DENSITY LEVELS
IN FOUR FREQUENCY BANDS

Frequency (MHz)	Site	Power density exposure (mW/cm^2)
Less than 400	Holy Cross Hospital	3.9×10^{-4}
400 - 1,000	Montgomery Mall	1.1×10^{-5}
1,000 - 3,000	National Airport	7.7×10^{-3}
3,000 - 10,000	National Airport	1.4×10^{-4}

Source: U.S. Department of Health, Education and Welfare, "Radiofrequency and Microwave Radiation Levels," p. 61.

The concern over possible health effects from human exposure to electromagnetic radiation grows as the sources of the radiation keep increasing. It is known that above exposures of 10 mw/cm^2 there are definite hazards related to the heat or thermal limits which critical tissues can stand. But very little is known about the more subtle effects from long term, low level exposures. Some reports describe physiological, biochemical and genetic alterations in plants and animals as well as behavioral and psychological changes in animals. A number of biological effects have been observed following microwave exposure.[8] The studies are primarily done with animals and the effects include cataract induction, abnormalities in cell function and central nervous system effects. One form of biological hazard which can exist at present environmental field strengths is interference with cardiac pacemakers.[9]

VII.C Health Hazards

The Electromagnetic Radiation Management Advisory Council (ERMAC) wrote a report assessing the biological hazards of nonionizing electromagnetic radiation in December 1971. The report stressed that there may be a potential hazard and that "man may soon enter an era of energy pollution." People living in urban areas where most broadcasting stations are located represent the population group with the most exposure to this type of radiation pollution. The exposure dose is still below the recommended U.S. maximum limit of 10 mw/cm^2. The Federal government is now doing research to determine if there is a need for standards because of possible biological effects and, if so, what they should be.

VII.D Climatic Changes

The city environment is known to produce climatic changes in comparison with rural environs. An especially significant change is the temperature difference which is found to be consistently higher in cities than outside of cities. The "heat island effect" describes this temperature difference. Annual averages of the heat island have been reported between 0.5°C and 1.2°C.[10] This discussion will present the research findings on this effect in Cincinnati, Ohio. The causes of the problem and the health effects will be reviewed. A case study of a heat wave in St. Louis will be presented. Some suggestions are made for dealing with the problem.

VII.D.1 Heat Island Effect

In a study of the heat island effect, urban-suburban temperature measurements were taken in Cincinnati, Ohio during August 1969. The results displayed in Figure 3 show that the suburban temperatures are consistently lower than those recorded in urban areas from 2:00 PM through 10:00 PM. The ranges between average afternoon (2-3:30 PM) and average evening (8:30-10:00 PM) temperatures over paved areas were 31.3 to 27.0°C at the urban site and 29.5 to 21.9°C at the suburban site. Further, the temperatures taken above grassy surfaces are lower than above paved surfaces in both the urban and suburban environments.[11]

The Stanford Research Institute has reported an average heat island temperature of 1.2°C higher near the downtown area than the typical area of its environs.[12] They point out that the highest temperatures of a city occur in that part of the downtown area with "densely packed three-to-five story buildings and parking lots." Higher urban temperatures seem to be directly related to the amount of concrete and asphalt surface area.

The temperature abnormalities in cities are caused by the retention of solar heat in the physical urban structure. In summer the buildings, pavement and concrete of the inner city absorb and store larger amounts of solar radiation than do the vegetation and soil typical of rural areas. At night the urban air is kept warmer by slow radiative losses of the absorbed heat. "A nocturnal urban heat island in excess of 8°C occurs occasionally in most large cities."[13] Less of the solar energy is used for evaporation in the city than in the country because precipitation just runs off of the streets and buildings. "The blanket of pollutants" absorbs part of the upward-directed thermal radiation emitted from the surface and re-emits downward or into the ambient air. Reduced wind speed between the buildings decreases the city's ventilation. In winter, man-made energy causes the same effects as solar energy. In fact, the effects are even more pronounced. Artificial heat results from combustion for heating, power generation, industry and transportation.[14]

VII.D.2 Health Hazards

In order to cope with environmental heat, man has several physiological mechanisms such as vasodilation and sweating. When the body is overburdened by the heat load, these physiological reactions are stepped up and lead to physical breakdowns or illnesses. The four major categories of heat-induced illnesses are heat exhaustion, dehydration, heat cramps, and heat stroke. When the heat stress is great enough then a stroke (which endangers the functioning of some vital tissue) can lead to death.[15] The normal relationship between temperature and mortality shows a decrease in the summer months. But when there is an urban heat wave episode the number of deaths markedly increases.[16] In St. Louis, Missouri during the month of July 1966 there were 570 "excess deaths"[17] from all causes. During that same time, heat was attributed as the primary cause of death in 246 out of 1420 death certificates (40 more stated heat as a contributing cause). Mortality from all causes increased by 56 percent in St. Louis from the urban heat wave of July 1966.[18]

Stanley Schuman did a study of the patterns of the deaths in St. Louis during the same heat wave. He found that certain subgroups were at a substantially higher risk than others. The high risk groups included persons over age sixty-five, census tract residents with low incomes, crowding or poor housing and patients with certain diseases. His findings are shown in Table 7.2 of the high and low risk tracts and the characteristics found within them.[19]

TABLE 23

DEMOGRAPHIC CHARACTERISTICS OF SELECTED CENSUS TRACTS[a] IN ST. LOUIS, JULY, 1966

Demographic Characteristics	High-risk tracts[b]			Low-risk tracts[c]		City of St. Louis
	Ldl	MC	Gfd	NW	Gdv	
Population (thousands, est. 1965)	23.7	15.9	58.6	28.8	18.7	728
Excess deaths						
Number	52	25	57	-6	-3	618
Percent	+260	+179	+110	-18	-10	+55.8
Median Age	35.1	26.2	20.6	40.5	43.3	33.6
Race (%nonwhite)	38.9	52.8	97.9	11.1	0.0	35.8
Median family income	$3600	$3400	$3500	$6200	$6700	$5300
Crowding (no. persons/ room)	0.70	0.83	0.72	0.53	<0.50	0.64

[a] Census data from 1960.
[b] High-risk tracts are: Ldl = Lindell, MC = Mill Creek, Gfd = Garfield.
[c] Low-risk tracts are: NW = Northwest, Gdv = Gardenville.

Source: Schuman, "Patterns of Urban Heat-Wave Deaths."

The heat island effect is clearly an urban problem as the building density and street surface can be shown to cause the increased temperature. This effect should be considered in the urban planning process. More land could be allowed for parks with grass and trees which help to decrease the temperature. Building materials of lower conductivity could also reduce the heating effect. In some instances where the extra heat may be a benefit, such as in colder latitudes, planning can be done to enhance the effect.

Heat waves should be included in emergency warnings to urban areas along with air inversions (which compound the air pollution problem). The significant increase in the death rate in large cities during these heat waves shows the magnitude this problem has reached. There are the "high risk tracts" of inner city, poor and unhealthy people who are the most susceptible to the effects of the heat island. Their situation now is beyond the urban planning stages and needs corrective help before the new city developments will be available.

FOOTNOTES

1. J. B. Little, "Environmental Hazards - Ionizing Radiation," New England Journal of Medicine, CCLXXV (October, 1966), pp. 929-938.

2. (One millirem equals 1/1000th of a rem. Rem stands for "roentgen equivalent man" and reflects an absorbed dose in human tissues.)

3. Commission on Environmental Quality 1971, Environmental Quality, p. 222. The "genetically significant dose" means the average dose to the sexual organs of persons of child-bearing age.

4. Council on Environmental Quality, Environmental Quality, 1971, p. 222.

5. The Mitre Corporation, Environmental Trends, (Washington, D.C., 1971), p. 4.

6. Council on Environmental Quality, Environmental Quality, 1971, p. 221. The population groups regulation is based upon a suitable sample of those exposed.

7. U.S. Department of Health, Education, and Welfare, Bureau of Radiological Health, "Radiofrequency and Microwave Radiation Levels from Man-made Sources in the Washington, D.C. Area," by Stephen W. Smith, et al., USDHEW Publication No. (FDA) 72-8015 BRH/DEP 72-5 (Washington, D.C.: Government Printing Office, 1971.

8. U.S. Department of Defense and U.S. Department of Health, Education, and Welfare, "A Partial Inventory of Microwave Towers, Broadcasting Transmitters, and Fixed Radar by States and Regions," Report BRH/DEP 70-15 (Washington, D.C.: Government Printing Office, 1970), p. 6.

9. U.S. Department of Health, Education, and Welfare, Bureau of Radiological Health, "Electromagnetic Radiation Interference with Cardiac Pacemakers," by P. S. Ruggera and R. L. Elder, Report BRH/DEP 71-5 (Washington, D.C.: Government Printing Office, 1971).

10. U.S. Department of Health, Education, and Welfare, Public Health Service, "City Air - Better or Worse," Air over Cities, by Landsberg, Technical Report A62-5 (Washington, D.C.: Government Printing Office, 1962), pp. 1-22.

11. J. F. Clarke, et al., "Comparison of the Comfort Conditions in Different Urban and Suburban Micro-environments," International Journal of Biometerology, XV, No. 1 (1971), 41-54.

12. F. L. Ludwig and J. H. S. Kealoha, Urban Climatological Studies. Final Report, Contr. OCD-DAHC-20-67-C-0136, (Menlo Park, California: Stanford Research Institute, 1968).

13. Clarke, "Comparison of Comfort Conditions," p. 41.

14. U.S. Department of Health, Education, and Welfare, Public Health Service, National Air Pollution Control Administration, "The Climate of Cities: Survey of Recent Literature," by James T. Peterson (Raleigh, N.C., 1969) pp. 9-10.

15. U.S. Department of Health, Education, and Welfare, Public Health Service, National Center for Air Pollution Control, "Heat Stress," *Seminar on Human Biometeorology*, by Austin F. Henschel (Washington, D.C.: Government Printing Office, 1964), pp. 95-108.

16. Paul H. Kutschenreuter, "Some Effects of Weather on Mortality," *Seminar on Human Biometeorology* (Washington, D.C.: Government Printing Office, 1964), pp. 81-94.

17. The number of "excess deaths" in any one month is calculated by just finding the differences between the number of deaths in the month with the greatest number of deaths (from heat) and the months preceding and following it. The differences are then averaged.

18. Stanley H. Schuman, "Patterns of Urban Heat-Wave Deaths and Implications for Prevention: Data from New York and St. Louis during July 1966," *Environmental Research*, No. 1, (1972), 68.

19. *Ibid*, p. 70.

SECTION VIII

FEDERAL POLLUTION CONTROLS: RAMIFICATIONS OF UNIFORM ENFORCEMENT[1]

VIII.A Introduction

The research task of this report is three-quarters fulfilled. It is the purpose of this final section of the report to utilize the data and analytical information provided heretofore in an effort to bring the question of uniform application of Federal pollution controls on the center city locale to a logical closure. Specific hypotheses are derived from which it is urged that further research be conducted. It is felt that the research objective of this report has been achieved and indicates that empirical research is needed. It is hoped that the analysis provided in this concluding section will lay the foundation for empirical exploration.

Essentially, application of uniform Federal pollution enforcement to the metropolitan community will differentially affect the center city and suburban locales. A criterion of uniformity will mean that an initial effort must be made in the center city in order to bring its environment on a parity basis with that of the suburb. A secondary effort will mean bringing both the suburban and center city locales on par with Federal environmental standards. Thus, it appears _prima facie_, that under the application of uniform pollution controls the center city will undergo an additional process compared to the suburban locale. Any imposition of uniform Federal pollution controls will place a stress on the economic and social sectors of the center city.

In this concluding section a functional approach is taken with respect to the economic and social costs associated with the application of uniform pollution controls. Within this functional theoretical framework, the two types of systemic ramifications are discussed. Operational hypotheses are developed as logical consequences of uniform pollution control applied to the center city locale.

First, an economic theory of the center city is presented. Within this framework, the economic costs of uniform enforcement are predicted on the basis of the costs associated with the externalities of production and the economic base function of the center city as a locus of employment. Second, the social costs of uniform enforcement are viewed within the framework of the center city as a complex of social and cultural functions. Functions intricately related to the environment. Primarily, the social costs are categorized into the structural and demographic variables effected by the application of uniform Federal pollution controls to the center city.

VIII.B Economic and Social Ramifications of Uniform Pollution Enforcement

The free enterprise system is based on the concept that land, labor, capital and entrepreneurship have some cost structure associated with their employment. Competition through the mechanism of the price system allocates these scarce resources to those consumers whose demand and, hence, whose willingness to pay, is greatest. Theoretically, all costs of a product are borne by the manufacturer who passes them on to the consumer in an equitable fashion.

Unfortunately, this is not economic reality. Certain costs of production have been externalized. They have been transferred to society in general at the benefit of a few. The costs being externalized manifest themselves as pollution. Allowing these externalities has destroyed much of the natural environment. These allowances have also stimulated economic growth and provided the world's highest standard of living. In the early parts of this report the impact of these externalities upon the center city was established. An obvious question still remains. What will be the specific economic effects of enforcing pollution controls in the center city?

A recent study listed four major effects of pollution controls upon the economy:

1. A reduction of the efficiency of capital in the aggregate production function;

2. An increase in the prices of consumer and capital goods;

3. An increase in the cost of capital per unit output;

4. The generation of new output and employment in industries producing abatement facilities through pollution control investments.

Generally, the first three effects can be considered negative; the fourth is positive, but not large enough to offset the previous ones. The magnitude of each of these effects will depend upon the three interrelated factors of city size, industrial mix, and location and employment mix.

Assuming that controls are uniformly enforced, the smaller the city the more severe the economic impact of pollution controls. There are several reasons for this. First, the existence of marginal industries in small towns is a well known phenomenon. These industries can be characterized by old, low efficiency plants that are kept open because of the severe political repercussions of closing them. Usually, these plants are part of a much larger company with many other production facilities. In the case of the small town, a decreasing efficiency of capital and increasing capital costs can be sufficient impacts to force closure. Also, since no pollution abatement equipment is produced in the town, any benefits accruing to new output and employment generated are totally external. When the plant is faced with the decision of operating at a loss or closing down, the latter becomes the chosen alternative in most cases. (It is interesting to note that protection of the environment can be used as a cry for closing down inefficient production facilities and replacing them with newer ones in different areas. Due to locational efficiencies accruing to industries near major transportation facilities, and production efficiencies in new plants, it is doubtful that plants closed down in small towns would ever be rebuilt there. After the plant closes, it is predicted that unemployment will rise, people will move out and the town will die.

In a large city, the closing down of a single plant would have less severe effects. Theoretically, workers could move from high polluting production facilities to low polluting ones as long as the required skills were similar. Further, the effects of decreasing capital efficiency and increasing cost of capital will be less severe in low polluting industries since little expenditures for pollution control are required. The economy of the metropolitan area might also support some pollution abatement equipment industries, and therefore experience some economic benefit. Concurrent to the growth in the abatement industry, will be growth in the ancilliary services such as barber shops, department stores, etc.

At this point a judgment must be made. Will the center city function as part of the metropolitan system? Or, will the effects of pollution control be similar to those of the small town? Physically, the center city is part of the overall metropolitan system. The unskilled worker of the center city tends to resist migration, and seeks other local employment. Even if he wanted to migrate and seek work elsewhere in the metropolitan area, it is doubtful whether he could afford it. By living and working within the inner city, a resident saves considerably on transportation costs. A typical resident might be faced with the problem of less net income at a future job because of transportation costs. This problem may become more acute when considered in the context of the requirements for mobile emission devices on automobiles. Cost of these devices is estimated at $300 per vehicle. A price rise of $300 per automobile becomes a highly regressive tax for the center city resident given the high proportion of low incomes. It is possible that a cost increase of that amount could virtually eliminate the automobile as an alternative means of transportation in the center city. The question of whether or not these effects will occur can also be viewed in the context of the economic mix of the center city.

Depending upon the economic mix of a center city, effects of pollution control could be very different. To draw on two examples at opposite ends of the spectrum is appropriate to illustrate this point. Assume a single industry city producing anti-pollution devices in a zero polluting production process. Also assume all production is exported out of the city. In this case, the imposition of pollution controls would turn this city into a boom town. New output and employment would be generated thus precipitating the development of a large group of ancilliary services. Even though prices would rise on goods imported into the city, the magnitude of the positive effects associated with local growth and development would probably more than compensate for the rise in prices. The net effect is beneficial to the city.

In contrast, assume a single industry city (using a heavy polluting production process, e.g. cement) producing a product only for consumption within the city. In this case, decreasing efficiency of capital, rising cost of capital and higher prices would have drastic effects upon the community. Since all production is consumed within the city, the total cost of pollution abatement is assumed by the residents. As prices rise, quantity demanded decreases, wages fall and the company is forced to close its doors. This precipitates the closing of the ancilliary service industries and the city dies.

These two somewhat unreasonable examples illustrate a major point. Both production and consumption of a city's economic output must be considered to analyze the effects of pollution controls. A reasonable way to approach this problem is through economic base analysis.[2] Cities which have a major portion of their basic employment in heavy polluting industries will be less affected than communities whose non basic industries are heavy polluters. Similarly, a heavy concentration of non polluting basic industries will cause large benefits to accrue to the city in question.

The implications of this for center city populaces are obvious. Those residents who are employed in basic industries will feel the effects of pollution control first. Effects will run the gamut from shut down to boom town depending upon the characteristics of the product and production processes. Non basic employment will be affected after the effects are felt in the basic industries. Since they supply services to the basic industries, non basic employment can be viewed as the more unstable, for they are at the mercy of local market fluctuations.

At this time the question of economic stability in the center city can be approached. Depending upon the economic base of the community, the effect of environmental controls on stability will vary. For example, if a heavy polluting basic industry is required to make ever-increasing investments in plant and equipment for environmental purposes, then consumption in the city will be induced to grow at a rate which would appear to symbolize growth and stability. However, the achievement of environmental objectives will cause a slow down in the investment function. Acting through the accelerator, this slow down will detrimentally affect consumption and indicate a cyclical, if not declining, urban economy. This scenario assumes benefits of increased industrial investment accrue only to the city in question. In reality this is not the case. Because no one urban area could be self-sufficient, the detrimental effects of pollution control can not necessarily be balanced by the positive effects. The scenario viewed above would only be correct for basic industries producing pollution control equipment whose investment serves to increase the efficiency of capital rather than decrease it. Further, the rising prices necessitated by the increasing cost of capital per unit of output will change the demand-supply relationship of the firm impinging upon the firm's ability to finance pollution expenditures. What appeared to be an obvious conclusion has again been changed by the addition of a structural factor. Earlier labor mobility reversed a conclusion. Now the interdependency of urban areas performs the same function.

Again, the discussion is applicable to the center city. Depending on the relationship of the urban area to other urban areas, impacts on center cities will differ. A relatively economically dependent urban area will experience more violent fluctuations caused by pollution control than will a relatively economically independent urban area. As for the center cities, the more violent fluctuations experienced by an urban area, the more violent the effects on the center city.

If we hypothesize that center city employment is predominately basic, unemployment trends will tend to follow that of the urban area as a whole. If we hypothesize a predominately non-basic employment, unemployment fluctuations will be greater than those in the urban area as a whole. This can be attributed to the presence of an employment multiplier effect between the basic and non-basic industries.

To further analyze the effects of pollution controls, one must deal with the employment mix of the center city. Employment mix pertains to the number of employees at each income level. The obvious implication is that the high income persons would experience less of the effects of pollution controls than low income persons. Price rises are more easily absorbed. Since these people are usually better educated, the jobs are more secure. Their mobility is higher and hence, greater opportunities are afforded to them. None of these characteristics are true for center city residents who are predominately poor, aged and disproportionately black. The phrase describing employment stability here is last hired, first fired. As indicated earlier, mobility is seriously hampered by cultural and economic factors. In other words, because the employment mix is heavily weighted toward the low side, the effects of pollution control will be more severe in the center city. Unemployment will be higher. Ability to absorb price increases on consumer goods will be lower.

VIII.C Summary of Macro Impacts

The severity of economic impacts from pollution controls upon the center city depends upon three interrelated factors: city size, industrial mix and employment mix. Generally, the center city functions much like a one industry dependent small town. Because of this, the industrial mix is very basic, i.e. most goods produced there are exported. Finally, the employment mix is heavily weighted toward the lower income side. All of these factors imply very strongly that enforcing pollution controls uniformly will have significant detrimental economic impacts upon the center city. Economic impacts which are more difficult to bear than those of urban areas as a whole.

It is now worthwhile to view some specific economic impacts of pollution controls on the center city resident. Where possible, dollar values will be used to illustrate the impacts.

VIII.D Impact of Air Pollution Control

The major legislative act to consider in air pollution control is the Clean Air Act (CAA) plus all of its various amendments. The general economic effects of implementation of this act have been examined. Indications are that implementation of CAA by 1975 in all states will have the following general economic effects:

Manufacturing Production	-- decrease	1.5%
Manufacturing Investment	-- decrease	21.0%
Personal Income	-- decrease	0.6%
Government Revenue	-- decrease	0.7%
Unemployment	-- increase	0.9%

This assumes no government assistance in the form of tax writeoffs, exemptions, investment tax credits, grants or loans and loan guarantees. The figures represent national averages. In reality, the heavily industrialized area of the Northeast and Great Lakes will be most severely impacted. Furthermore, within these regions, center cities will be hurt the worst. Some general impacts to be considered are rent increases, unemployment increases, and decreasing health costs.

Rent increases will be precipitated by a lack of investment capital flowing into the center city housing market. A tightening housing market will be manifested in increasing rents. Also, municipal taxes and utility rates will increase as utilities comply with CAA and municipal governments deal with the ever-increasing city tax base. All of this implies a higher cost of shelter for the center city resident. A rise in unemployment via the mechanisms described earlier is inevitable. Given the employment mix of the center city, the results of enforcing CAA might increase center city unemployment two or three times the national average.

Decreasing health costs are an obvious benefit of air pollution control legislation. Loye and Siskin[3] argue the following cost saving would accrue if air pollution in major urban areas was lowered by 50 percent:

Disease	Decline in Incidence	Cost Saving/ Year (millions)
Bronchitis	25 - 50%	\$250 - \$500
Lung Cancer	25%	33
All Respiratory Disease	25%	1222
Cardiovascular Disease	10%	468
All Cancer	15%	390
Total		\$2363 - \$2513

This is approximately 4.5 percent of all costs of mortality and morbidity. Although these savings would not accrue equally across urban areas, substantial benefits would accrue to center city residents over the long term. However, certain negative social costs are attached to declining mortality These implications are drawn later in this report.

In an effort to comply with CAA, it is possible that certain cities (EPA identified New York, Chicago, Philadelphia, Los Angeles, Denver and Washington) will have to limit automobile use in the downtown area.[4] The effects of this type of action on local merchants who provide employment for center city residents are unknown over the long term. Certain cities have banned automobile traffic in downtown shopping areas at selected times with mixed results. One point must be stressed. Limiting access to the center city also serves to limit access out of the center city. Unless there is some alternative means of transportation (e.g. mass transit) actions in this direction could wreak havoc with the urban economy and the center city resident.

VIII.E Impact of Water Pollution Controls

Both industries and municipal governments will be taking action in efforts to eliminate water pollution. Federal law limits effluent discharge by industry into waterways. The law requires the use of the best practicable technology for effluent control by 1973. Certain industries such as paper, chemicals, oil, plastics and textiles will be the most affected by the requirements. The degree that production facilities of these industries are located in center cities will determine the effect of these pollution controls upon the residents. Unemployment would be the major effect caused by controls on these industries.

Governmental action to curb water pollution will be directed in three major areas that will have substantial impact upon the center city resident: drinking water, waste water treatment and recreational facilities. In efforts to improve drinking water, the Federal government monitors and classifies municipal water supplies according to pressure, and health requirements. Impacts of this action upon center city residents is negligible. However, if a government were to outlaw lead pipes used for drinking water transmission in an effort to improve city water quality, there would be significant effects upon center city residents. First, those residents who owned homes with lead piping would be required to replace it with copper or some other acceptable material. Similarly, landlords would be required to replace all lead piping their housing units or face condemnation. Neither resident nor landlord could bear the cost of removal and replacement. A reasonable estimate for this type of work would be $1500 to $2000 per unit.[5] Landlords would be unable to sustain these expenditures without raising rents. Home owners would also be exposed to economic hardship if forced to bear the cost. Although municipal or Federal funding of this type of program is a possibility, the revenues would have to come from taxes which would be unfair to those not receiving the benefits. Whereas this might be tolerable on a scale such as the Federal programs today, the cost of replacing all piping in homes built before copper (around 1945) and plastics (around 1965) were used would be absolutely staggering.

Governmental action to improve waste water treatment involves funding and construction of sewers and sewage treatment plants. Although the Federal government is financing 75 percent of the cost many cities will still have trouble raising the needed capital. Increased taxes and sewer connection fees along with some type of long term financing, e.g. municipal bonds, seem to be the only reasonable methods for raising the necessary capital. In any case, the center city resident will be forced to assume some of the costs. An interesting point arises when one considers the effects of public works construction. The fact that government expenditures in an area stimulate local economics is well known. In fact, public works expenditures can be used to revive urban economics suffering from other pollution control impacts. The benefits accruing to the center city economy because of the public works project might well exceed the costs incurred by the residents.

A final area of government action will be the improvement of water based recreational facilities. The proximity and availability of the improved water based facility will determine its usage patterns among center city residents. Taxing the center city resident to improve facilities that are relatively unaccessible to the center city is subsidizing other areas of the city at the center city's expense. To the extent that the improved facilities are available to the center city resident will determine the impact of this effort upon the center city.

VIII.F Impact of Noise Pollution Control

The major sources of urban noise were discussed earlier in this report. Noise levels were shown to be higher in the center city than in the urban area as a whole. The costs of "quieting" the center city would probably not have much effect upon center city residents. Obvious exceptions to this would be industrial noise and noise from transportation vehicles.

Forcing center city industries to quiet their production processes or move to outside areas that permit existing noise levels causes unemployment to rise. The mechanism being similar to that of air and water pollution controls. Similarly, effecting noise controls upon transportation facilities would result in higher user costs. This would be true for buses, subways and other mass transit vehicles. Traffic noise could be lowered by the rerouting of all non essential traffic. However, the problem would not be solved, only transferred to another area.

VIII.G Impact of Solid Waste Pollution Control

The basic economic question in solid waste pollution control is who will pay for the necessary effort to achieve a cleaner, more livable center city. Over 75 percent of solid waste collection and disposal costs are directly paid in the form of taxes, user charges or fees for service.

Because the center city resident pays less taxes and generates equal or greater waste than his suburban counterpart, the service being provided (assuming equal performance levels) has greater economic efficiency in the center city. Therefore, any increased service level in the center city without a differential tax increase to the center city resident provides him a positive economic gain. Similarly, the development of alternative means of solid waste disposal provide a net economic gain to the center city resident because of the relatively small center city tax base.

VIII.H Some Other Impacts of Pollution Controls

The economic impacts of pollution control upon the center city in the areas of radiation and pesticides are very small. The area of pesticides, however, is worth mentioning. Eliminating pesticide pollution in the center city would precipitate rapid growth in the numbers of household pests. If single use, non toxic pesticides were developed and marketed, there would be a net economic gain. Household pests would be eliminated and a major health hazard would be minimized. However, if the use of agricultural pesticides was severely curbed, negative effects in the form of higher food prices would face the center city resident.

VIII.H.1 Social Costs

It is felt that the center city is more than an economically determined subsystem. To the extent that application of uniform environmental controls will affect the entire system of the center city, it is necessary to follow its logical ramifications to the center city as a social structure. The question of uniform pollution control as a diseconomy to the employment base of the center city has been well pursued. As indicated at the outset of this report, the critical structural factors influencing any move to improve the center city environment should be age, size and density. It will be shown now, that these three factors are associated with the probable social costs involved in uniform enforcement of Federal pollution controls in the center city. The social costs to be examined here are transportation, housing, age distribution, the labor force and migration.

The obvious result of applying uniform Federal controls is positive from the standpoint of the center city. That is, a metropolitan center city locale which meets Federal pollution standards would be an upgraded environment. Given the unique characteristics of the center city, the negative implications of uniform enforcement may be less obvious. Paramount among these are social costs.

It has been suggested by classical urban theorists that the city is a complex of social and cultural factors constituting a distinct way of life. It is argued here that the environment can be considered an inherent component of the center city life style. Environmental concerns then become life-style concerns. The question then becomes one how does uniform enforcement of pollution controls disrupt the life style of the center city population? Further, it can be asked whether or not elevating the center city environment to comply with Federal standards will produce stressful living conditions in terms of certain social parameters. Finally, it is felt that measuring social ramifications is a valid technique in assessing the equity of applying uniform pollution controls to the center city locale.

VIII.H.2 Housing

Housing problems associated with uniform enforcement are primarily those resulting from structural obsolescence and overcrowding of center city dwelling units. According to the National Commission on Urban Problems, a greater incidence of substandard and crowded housing units exists in the center city than in the suburban locale. The Commission also points out that housing problems in center city poverty areas are more acute than in the center city as a whole. It is hypothesized that application of current and proposed Federal environmental controls may increase the proportion of substandard housing in the center city. Air, water and noise controls would significantly alter the types of currently acceptable internal heating, plumbing and insulating systems in center city houses. For example, if all landlords and homeowners in the center city were required to insulate housing units to meet Federal noise standards, the result might be abandonment of the housing unit rather than paying the dollar costs of insulation. Investigation is needed to determine whether or not present housing structures in the center city can withstand the installation of new heating, water and insulation systems. Further, if abandonment of center city housing units is a probable outcome of uniform enforcement, research is needed to determine the resulting relocation needs and preferences of the center city resident. One possibility to an abandoned house when relief housing is unavailable or nonexistent, is squatter settlements. It is hoped that this latter alternative is not within the realm of possibilities, but it is highly improbable. Empirical research would provide a basis on which to calculate the probability of all possible outcomes to the question of center city housing and uniform pollution controls.

VIII.H.3 Transportation

The second area of social consequences of uniform enforcement is transportation. It was shown in the discussion on the demographic composition of the center city that the population of the center city is disproportionately black. It was also pointed out that the center city has a higher percent of the population over age 65 and a lower median income than the suburbs. First, it can be assumed that a population with a large percent aged and lower income families would be dependent on public transportation. This assumption may not necessarily hold for blacks,[6] but for the argument here, its validity is assumed. Second, if application of uniform environmental controls reduces the number of automobiles or buses in the center city either through increased costs or restrictive entry measures, it is hypothesized that transportation for center city residents may prove to be oppressive. Lack of adequate transportation to places of employment, medical care and schools may put these places out of the reach of the average center city resident.

The application of a Federal pollution control which reduces the availability of public transportation in the center city would have the effect of increasing an already severe problem. Data for the 123 largest cities in the Metropolitan U.S. indicates that the emphasis of local governments is toward municipal highway expenditures and away from public transportation. The more local governments allocate monies to highways, the less the number of buses in the city.[7] A more significant problem with present public transportation is the relationship between increased demand and supply functions in the center city. It is assumed that a characteristically poor and nonwhite center city population would transmit a greater need for public transportation than the suburban population. The reliance on commuter transportation, especially the automobile, reduces the suburban demand on local, interurban transportation. It would appear then that as the center city poor and black population increased, the supply of public transportation would also increase. Further, it is hypothesized that as population density increased in the center city, public transportation would also increase. The latter would alleviate traffic congestion and the associated pollution problems. Empirical findings indicate no relationship between the number of buses and increased population density within the center city locale (r=.09). Similar findings were evidence for change in percent poor and change in percent nonwhite populations. The interpretation of the findings indicates that increased public transportation demands as measured by increases in the center city poor and nonwhite populations, is not met by increased supply, as measured by the number of buses in the center city.[8]

It is argued here that consideration of the current transportation picture in the center city must be made before uniform Federal pollution controls are applied. The data show that the center city locales of the metropolitan area have a critical shortage of public transportation. Moreover, municipal governments apparently are unresponsive to increased transportation needs. The most significant finding in the analysis of transportation in the center city was the fact that approximately 67 percent of the variation in bus shortages in the center city is explained by increased population size (r=.82). It is suggested that this inadequate supply of public transportation has forced center city and suburban workers to rely heavily on private automobiles. The "Survey of Working Conditions, 1970" found that 70 percent of the workers interviewed rode to work in their own cars or motorcycles.[9]

VIII.H.4 Age Distribution

Age distribution is the third major category in which application of Federal pollution controls may produce significant changes in the social structure of the center city. It is proposed that the imposition of any Federal control which decreases environmental health affects may conceivably alter birth and death rates in the center city. It is hypothesized that deaths related to air pollution episodes and excessive heat may be reduced through environmental controls. Data presented earlier pointed out that high risk populations for heat-related deaths are the poor, aged and black residents of the center city.[10] Further, infant populations exposed to higher lead concentrations,[11] virus contamination of water[12] and excessive heat[13] in the center city has been shown to contribute to the infant mortality rates.

Second, the dynamics of the age structure of the center city works in conjunction with improved health conditions and corresponding drops in the mortality rates. A center city affected by the application of uniform Federal environmental controls will probably improve the health conditions in the area. It is hypothesized that such an impact on health conditions would be evidenced in a declining mortality rate. The most marked decline would be in the very young and very old segments of the population, those under 10 years of age and over 50.[14] The subsequent drop in infant and aged deaths as a result of Federal environmental controls will provide a center city population with a larger proportion young and aged than exists currently. Further, there is evidence to suggest an effect on increased birth rates. If empirical evidence can be established between virus induced spontaneous abortions and potentially hazardous virus contaminated drinking water, then it is possible to predict a relationship between improved drinking water and increased birth rates.[15]

VIII.H.5 Labor Force Participation

The impact of uniform Federal enforcement of pollution controls and the ramifications to the economic base of the center city has been thoroughly analyzed. However, the consequences to the labor force and the implications of migration of workers remains to be discussed. First, it is proposed that one important impact of uniform Federal pollution controls on the center city will be decreased labor force participation for certain sectors of the center city population.

Second, it is proposed that a decreased labor force will produce increased out-migration from the center city.

One method of analyzing the degree of labor force participation for a population is the unemployment rate. It is hypothesized that the greatest impact of applying uniform environmental controls will be decreased labor force participation of the center city minority populations. A utilization of race-specific labor force participation data adequately reflect this predicted negative change in labor force participation rates. Again, it appears that the ramifications of uniform Federal pollution controls to the center city will confound an already negative situation. Unemployment rates in 1970 for all males in the center city locale was 4.9 percent compared to a 3.6 percent rate in the suburbs. For females, the rates were reversed 5.0 percent and 5.2 percent respectively. (These figures reflect the fact that most suburban females are classified as housewives and do not participate in the labor force). For the black population in the center city, the male unemployment rate was 7.5 percent. The figure was 7.8 percent for unemployment for black females in the center city for 1970.

Consequently, the labor force participation for the center city male population, as measured by unemployment rates in 1970 was 1.3 percent less than the suburban labor force participation. For females, the center city-suburban difference was negligible, a 0.2 percent increase in unemployment for suburban women. A control for race indicates a 3.9 percent increase in unemployment for black center city males compared to white suburban males. In addition, the race-specific figures for the female metropolitan population shows a higher unemployment rate for black center city females than the white suburban and white center city females. (7.5 percent compared to 5.2 percent and 5.0 percent respectively).

It was pointed out in the section of this paper on sources and nature of water pollution that certain industries contributed heavily to the differential level of water pollution in the center city. The mean values for black participation rates in thirteen industries range from 6.6 percent to 21.8 percent. The grand mean is 14.2 percent. With respect to the previous discussion on the impact of uniform Federal pollution controls on center city transportation, it is significant that 21.8 percent of black participation in the metropolitan labor force is in local and interurban transit. On the average, almost 14 percent (13.9%) of the black labor force participation is in contract construction. An astonishing 29.0 percent of this participation is in Atlanta and another 26.6 percent in Philadelphia.

The association between contract construction and differential noise levels in the center city was reported earlier. It is hypothesized that noise pollution control which affects contract construction will consequently affect the labor participation rates for that industry. It is predicted that this will be a negative effect, thus reducing the participation rate of workers in this industrial sector particularly for the black population. The phenomenon of the "last hired, first fired" may become operative.

VIII.H.6 Migration

To the extent that application of uniform Federal pollution controls increases unemployment in the center city, it is possible that massive out-migration may take place over a substantial period of time. The population will seek employment outside of the center city. Second, if the controls have a differential effect on any particular region within the metropolitan United States, regional migration may occur. For example, it has been shown in the earlier section of this report that air pollution differentials between the center city and suburban locales are greatest in the northeast region. Consequently, the application of a uniform Federal air pollution control will predictably have its most severe impact on the northeastern center cities. It can be hypothesized that workers in that region will respond to increased unemployment by moving to another region. Further, it is predicted that the migration patterns will be across regions such that a worker in a northeastern center city will migrate to a center city locale of another region. Moreover, the possibility of a regional center city to suburb migration is not at all improbable. Regardless of the direction of the move, any sudden changes in out-migration from the center city will have the effect of redistributing the present metropolitan United States population.

VIII.I Conclusion

In conclusion, the logical consequences of the application of uniform Federal pollution controls in metropolitan communities will be indeterminate changes in the economic, social and demographic structure of center city locales. Further empirical research in the field of uniform Federal environmental controls is seriously needed before definitive conclusions can be reached about the direction and magnitude of expected change. The data presented in this report have been used to develop specific hypotheses for empirical test. Specifically, it is hypothesized that the application of uniform Federal pollution controls will:

- decrease the mortality rates in center city locales
- increase the population under age 10 and over age 50 years in the center city
- increase the birth rate in the center city
- increase center city transportation problems for the poor and aged
- increase center city housing problems, especially increase housing abandonment
- decrease the labor force participation through increased unemployment, especially for the black population

- increase regional and local out-migration over the long term
- decrease center city population density
- increase particular regional center city and suburban densities
- decrease the absolute number of marginal industries
- shift the economic base of the center city, thus creating severe unemployment problems in certain sectors.

FOOTNOTES

1. The reader should be advised that several references and footnotes could not be located prior to final reproduction of Section 8.0.

2. Industries which export are considered to be the generator of the local economy. These are termed basic industries. Industries which serve the local market are termed non basic. By calculating ratios (between basic and non basic industries and assuming that these relationships hold constant over the forecast period, the economic growth and stability of a community may be projected. Usually these ratios are expressed with employment data. A good reference for economic base studies is Charles M. Tiebout, The Community Economic Base Study, Supplementary Paper No. 16 (New York, Committee for Economic Development).

3. Lester B. Loye and Eugene P. Siskin, "Air Pollution and Human Health," Science (August 21, 1970), pp. 723-732. See pages 729-730 in particular.

4. Wall Street Journal, February 1, 1971, p. 2.

5. Costs would vary significantly depending upon the number of plumbing fixtures present, the amount of pipe required and the availability of piping substitutes (some areas require the use of certain types of piping). Replacement of plumbing would involve removal and replacement of walls, ceilings and floors. Also, costs would be significantly higher in large metropolitan areas than in small towns because of wage differentials. (These estimates are based upon discussions with Mr. Irving Kursh, Secretary-Treasurer of Bells Supply Co., Inc., Wilmington, Del.)

6. Differential consumption patterns for the black population would suggest a greater reliance on private automobiles.

7. Pamela C. Cooper, "Factors Affecting Resource Allocation Within U.S. Cities" (Unpublished manuscript). A multiple regression analysis evidenced a negative zero-order correlation between municipal per capita highway expenditure and number of buses ($r = -.08$).

8. Ibid. Zero order correlations ($r=.01$).

9. University of Michigan Survey Research Center, "Survey of Working Conditions - Final Report" (1970), p. 247.

10. House Committee on Interstate and Foreign Commerce, Safe Drinking Water.

11. Ibid.

12. Stanley H. Schuman, "Patterns of Urban Heat-wave Deaths and Implications for Prevention," Environmental Research, V, No. 1, p. 68.

13. U.S. Congress, Senate, Committee on Labor and Public Welfare, Lead Based Paint Poisoning Amendments of 1972, Hearings before a Subcommittee of the Committee on Labor and Public Welfare, March, 1972, pp. 9-10.

14. The mechanism through which improved health conditions effect age composition is discussed by Bogue in Principles of Demography.

15. A suggested association between spontaneous abortions and potentially hazardous drinking water is presented in Safe Drinking Water, pp. 379-404.

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Pamela Cooper, Samuel Kursh, Jeanie Rae Wakeland, Margo Van Winkle, Mary Zoller

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Recent studies have focused attention on the fact that residents of inner-city neighborhoods are subject to greater amounts of pollutants than are other neighborhoods of large cities. In this study, Pollution and the Municipality, the premise is set forth and investigated at the metropolitan scale, seeking to discover differences of impact between the center city and its suburbs.

The report hypothesizes differentials of a generalized metropolitan area, by pollutant types, by interpreting diverse information sources. The findings were looked at in the light of standards imposed by federal and state regulation, first uniformly enforced, then implications for variable enforcement.

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